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The Potential Contribution of Cluster Developments to Maximising Economic Recovery in the UKCS

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Research in North Sea Economics has been conducted in the Economics Department since 1973. The present and likely future effects of oil and gas developments on the Scottish economy formed the subject of a long term study undertaken for the Scottish Office. The final report of this study, The Economic Impact of North Sea Oil on Scotland, was published by HMSO in 1978. In more recent years further work has been done on the impact of oil on local economies and on the barriers to entry and characteristics of the supply companies in the offshore oil industry.

The second and longer lasting theme of research has been an analysis of licensing and fiscal regimes applied to petroleum exploitation. Work in this field was initially financed by a major firm of accountants, by British Petroleum, and subsequently by the Shell Grants Committee. Much of this work has involved analysis of fiscal systems in other oil producing countries including Australia, Canada, the United States, Indonesia, Egypt, Nigeria and Malaysia. Because of the continuing interest in the UK fiscal system many papers have been produced on the effects of this regime.

From 1985 to 1987 the Economic and Social Science Research Council financed research on the relationship between oil companies and Governments in the UK, Norway, Denmark and The Netherlands. A main part of this work involved the construction of Monte Carlo simulation models which have been employed to measure the extents to which fiscal systems share in exploration and development risks.

Over the last few years the research has examined the many evolving economic issues generally relating to petroleum investment and related fiscal and regulatory matters. Subjects researched include the economics of incremental investments in mature oil fields, economic aspects of the CRINE initiative, economics of gas developments and contracts in the new market situation, economic and tax aspects of tariffing, economics of infrastructure cost sharing, the effects of comparative petroleum fiscal systems on incentives to develop fields and undertake new exploration, the oil price responsiveness of the UK petroleum tax system, and the economics of decommissioning, mothballing and re-use of facilities. This work has been financed by a group of oil companies and Scottish Enterprise, Energy. The work on CO2 Capture, EOR and storage was financed by a grant from the Natural Environmental Research Council (NERC) in the period 2005 – 2008.

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The Potential Contribution of Cluster Developments to Maximising Economic Recovery in the UKCS

Professor Alexander G. Kemp and Linda Stephen

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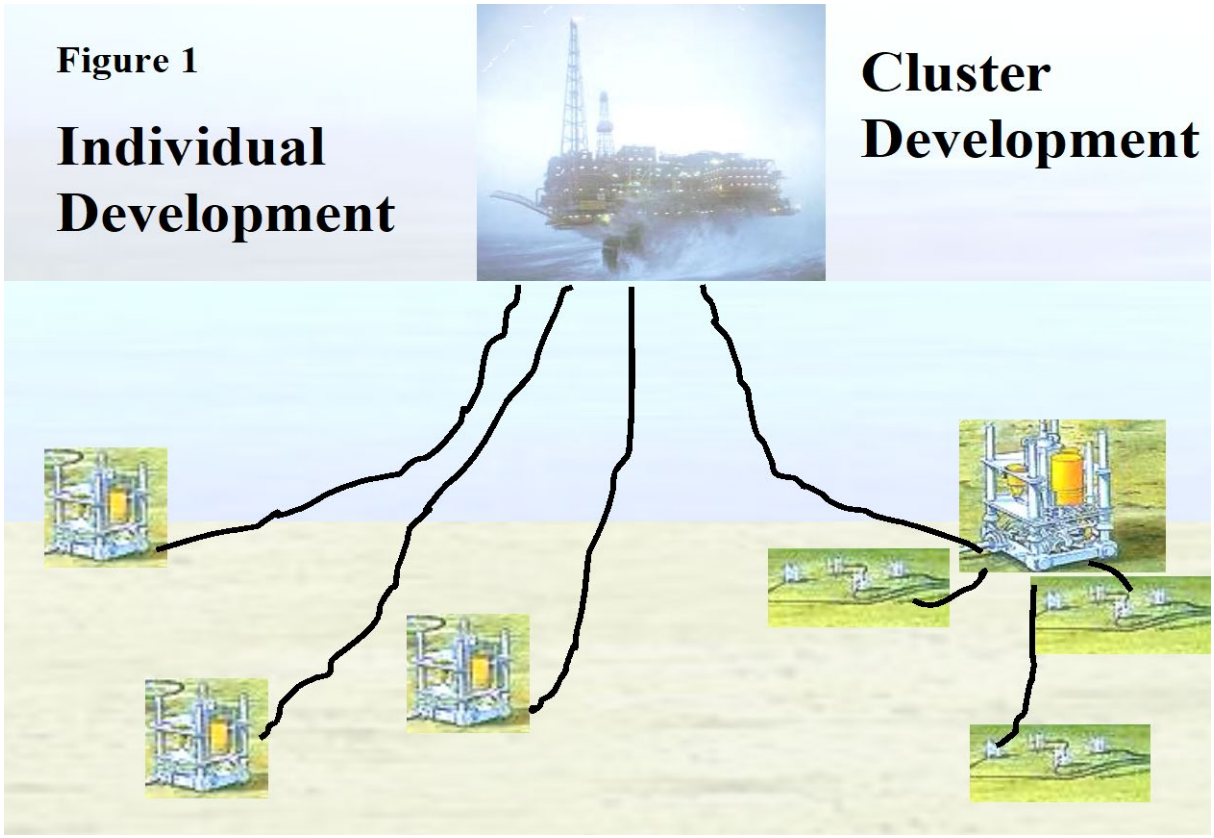
1. Introduction

The pursuit of Maximum Economic Recovery from the UKCS (MER UK) is a key objective of the Oil and Gas Authority (OGA) which is now accepted by licensees. To this end licensees have accepted the need for enhanced collaboration. This can be pursued in various ways. One relates to field developments being undertaken in clusters rather than on a stand-alone basis. This can produce economies of scale which may be substantial. For example, with stand-alone developments each field would have its own full producing system plus infrastructure access (e.g. via pipeline) to a large existing hub (which could be a major host platform tied into a major pipeline). A cluster development could incorporate a common infrastructure with a subsea manifold and associated facilities for communal use. There would be only one pipeline from the manifold to the major hub infrastructure. An illustrative example is shown in Figure 1.



The purpose of this paper is to investigate the extent to which cluster developments can enhance economic recovery in the UKCS. This involves assessing the scope for cluster developments in the different parts of the UKCS, taking into account the technical and economic feasibilities.

2. The Current Undeveloped Discoveries (Technical Reserves)

Currently there are over 400 undeveloped discoveries not classed as probable and possible developments by licensees. They are here termed technical reserves. Information on their sizes, types (oil, gas or condensate), and location by five main geographic areas is shown in Tables 1-5.

Table 1

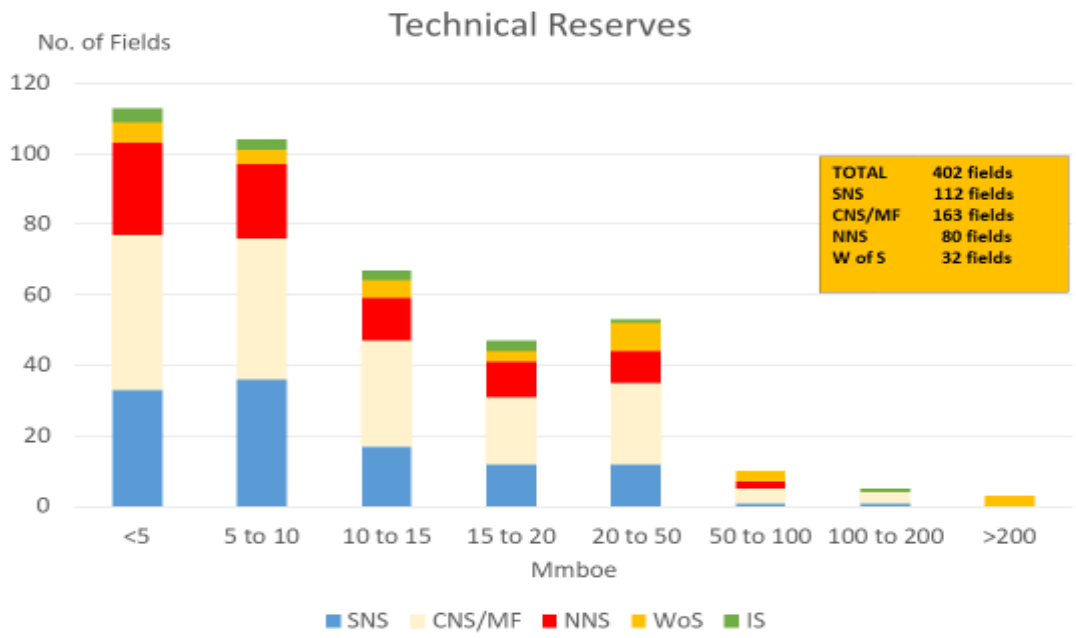
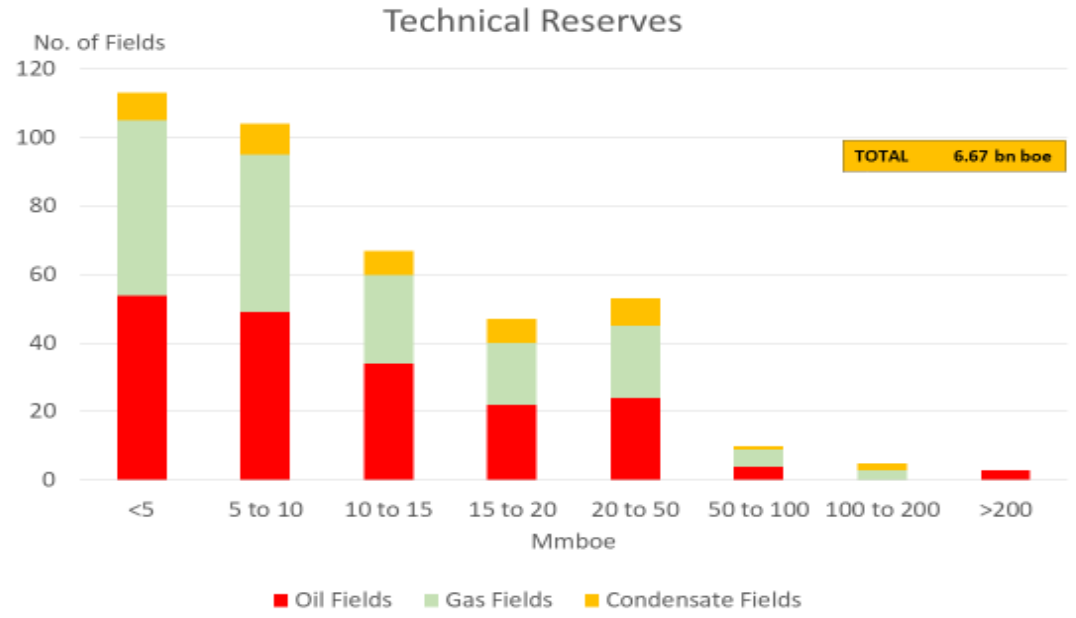


Table 2



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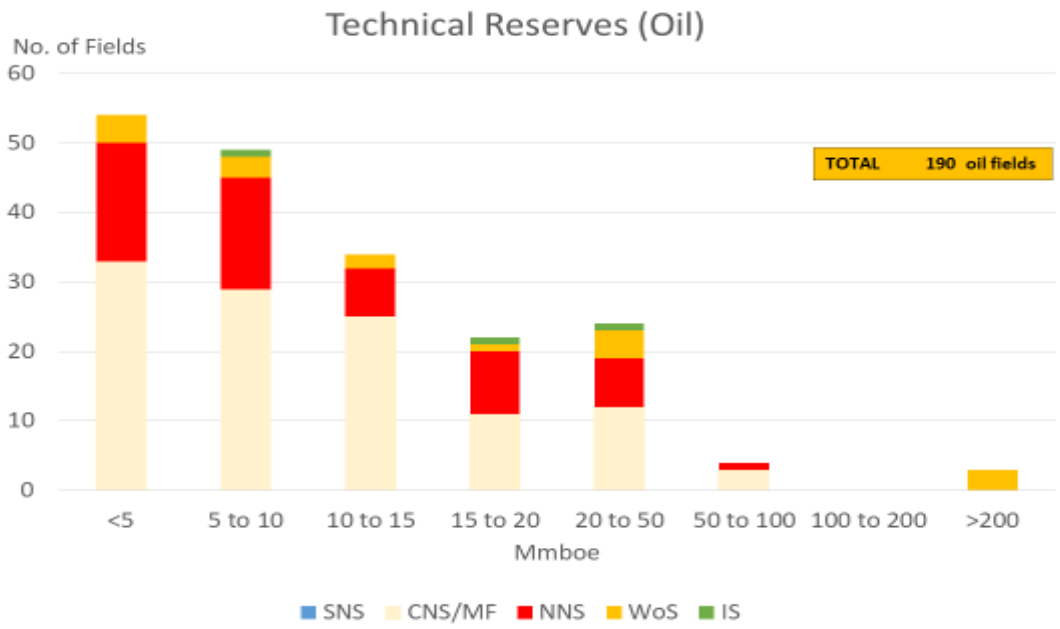

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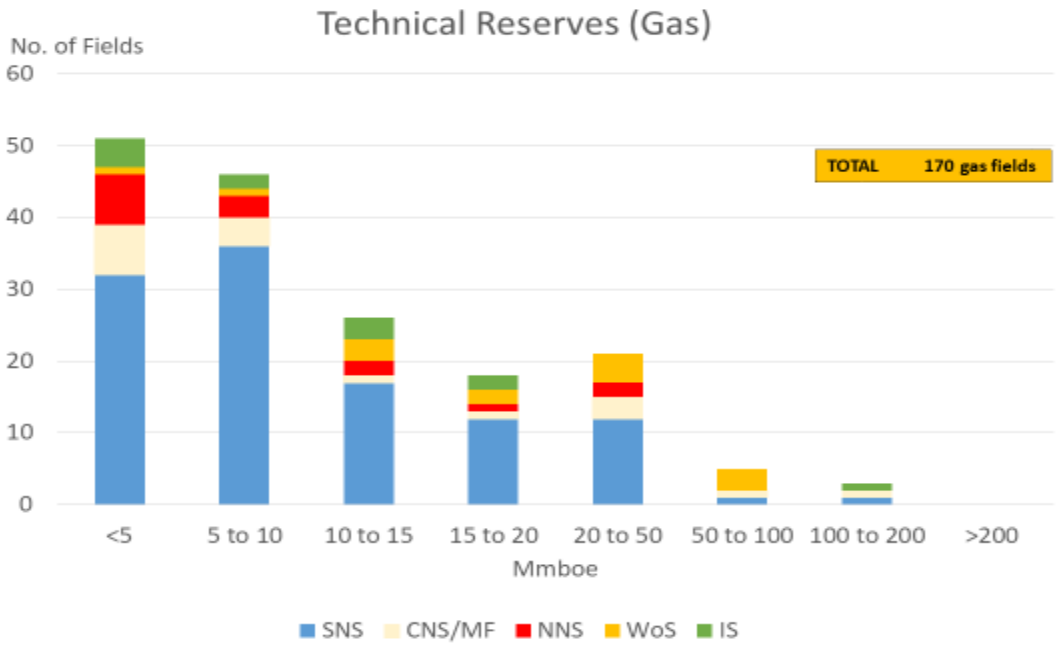

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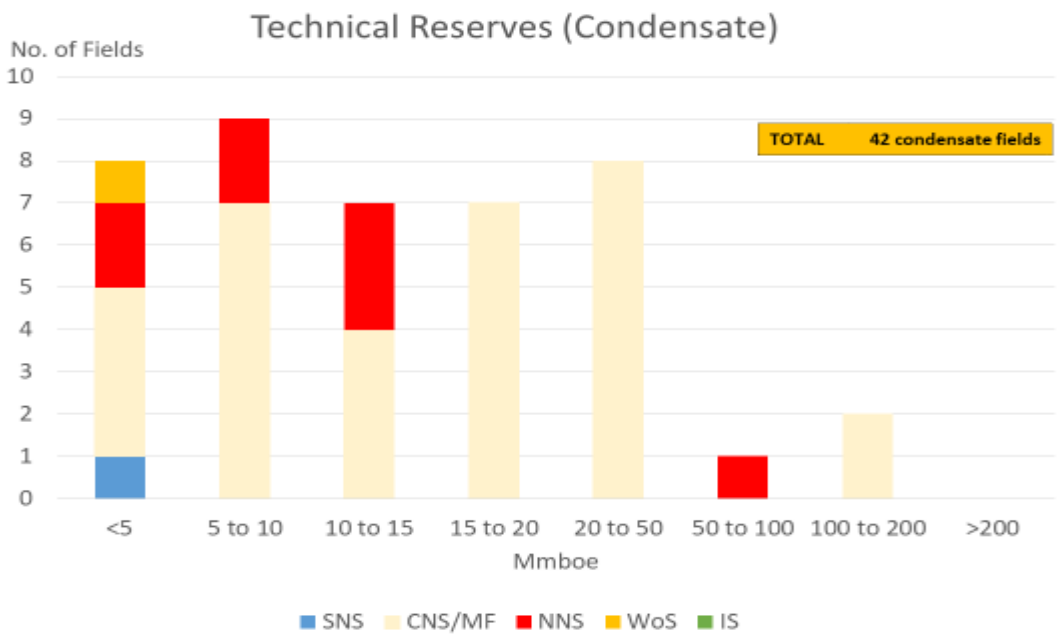

It is seen from Tables 1-5 that the great majority are very small which means that their economic viability, at least on a stand-alone basis, is likely to be challenging.

Many of the discoveries have remained undeveloped for a very long time. Some have been relinquished by the licensees who made the discoveries. Some are also located far from existing main infrastructure (hub platforms and pipelines) which also have quite limited economic lives. The employment of cluster developments offers the possibility of reducing the unit costs and rendering at least some more of them economic.

3. Modelling Assumptions for Stand-Alone and Cluster Developments

As only summary data relating to potential reserves, location of discovery, and type (oil, gas, condensate) were available estimates had to be constructed on the development and operating costs of the fields. Information on the development costs of fields in the categories of probable and possible reserves are known to the authors. This data was employed to create cost estimates for the technical

reserves. Several assumptions had to be made. A main one was to state that the average development costs for the technical reserves would be $5 higher per boe. As a result of this assumption the average development costs for the technical reserves for each of the main regions of the UKCS were as in Table 6.

Table 6

Average Development Costs per boe for Technical Reserves by Region ($/boe)

SNS	CNS/MF	NNS	WoS	Irish Sea
16.44	23.53	26.62	21.50	25.00

Monte Carlo modelling was then employed to determine a probability distribution of these costs per boe. A normal distribution with SD = 20% of the mean value in each region was employed. The resulting distributions produced minimum and maximum values.

A similar procedure was employed to find the distribution of the size of reserves. The values available to the authors were used as mean values. The resulting mean values and range using the Monte Carlo technique are shown in Table 7.

Table 7

Distribution of Sizes of Technical Reserves in Main Regions of UKCS (mmboe)

mmboe	SNS	CNS/MF	NNS	WoS	Irish Sea
Average	11.72	15.5	12.15	47.92	20.01
Minimum	0.18	0.53	1.34	0.92	0.53
Maximum	128.74	197.86	71.83	450.95	152.10

A uniform distribution was used to match each technical reserve to a development cost from the relevant area. This gave the average, minimum and maximum technical reserves development cost ($/boe). These are shown in Table 8.

Table 8

Average, Minimum, and Maximum Development Cost in Main Regions of UKCS ($/boe)

	CNS	SNS	IS	WoS	NNS
Average	19.33	15.56	15.72	19.75	20.55
Minimum	9.62	7.55	11.27	10.60	10.58
Maximum	34.93	27.28	21.15	29.91	29.73

However, it is likely that the unit development costs are related to the size of the technical reserves. For fields with greater than average reserves the development costs were postulated to be as follows:

$$sd + ((ad - md)/(mar - ar)) * ((ar - \text{actual reserves})*1)$$

and for fields with less than average reserves the development cost was postulated to become

$$sd + ((mad - ad)/(ar - mr)) * ((ar - \text{actual reserves})*1)$$

where :

Average reserves = ar

Minimum reserves = mr

Maximum reserves = mar

Set Devex (recent known development cost + $5) = sd

Average Devex = ad

Minimum devex = md

Maximum devex = mad

It was found that most of the technical reserves are located sufficiently close to each other to make cluster developments feasible. For the cluster developments the development cost calculation was as follows:

If a cluster has greater than average reserves then the unit Devex becomes

$$sd + ((ad - md)/(mar - ar)) * ((ar - \text{actual reserves})*0.8)$$

If a cluster has less than average reserves then the unit Devex becomes

$sd + ((mad - ad)/(ar - mr)) * ((ar - \text{actual reserves})*0.8)$.

When these calculations gave an unrealistic development cost a minimum for each region was used.

Each technical reserve field was given a production and investment profile based on their summary reserve data, block location and the calculated development costs.

The clusters of fields were formed on a geographic basis. Very broadly they relate to quadrants. They also relate to the infrastructure of pipelines and processing hubs which are expected to be available for a considerable number of years. The maximum distance over which a new field is tied into infrastructure is assessed to be around 25km. When the geographic mapping exercise was completed the overall result was that there were 80 clusters covering a total of 401 fields. In a few cases a field was attributed to more than one cluster. Further details of the clusters and the linked infrastructure are given in the section below on results.

In the modelling three price scenarios were employed, namely (1) $60/bbl and 40 pence/therm, (2) $70/bbl and 60 pence/therm, and (3) $50/bbl and 35 pence/therm, all in real terms at 2019 prices. The current tax system was employed. It was assumed that licensees assessed the potential investments on a project basis and utilized the Ring Fence Expenditure Supplement for

Supplementary Charge. Investment hurdle rate of NPV/I ≥ 0.3 was employed as the base case. A high case of NPV/I ≥ 0.5 was also executed. In addition, the results for post-tax real NPVss (RNPV) at 10% are also shown. These show the scale of the potential returns. In some cases an investment had a positive RNPV but still failed the NPV/I ≥ 0.3 hurdle. These cases are also shown in the results.

One somewhat paradoxical result of the comparative modelling of stand-alone and cluster developments was the occasional finding that the NPV and economic recovery of the latter could be less than the NPV and economic recovery of the former. This could occur when, say, one field on a stand-alone basis was quite profitable while the others were noticeably unprofitable. When a cluster was formed, although there were cost reductions, the losses of some members were such that the cluster was not very profitable with the result that the NPV of the cluster was less than that of the single field which was quite profitable on a stand-alone basis.

4. Results of Cluster Mapping and Economic Modelling

The results are shown by Quadrants and related block numbers for potential hubs.

1) Quadrant 2

Quadrant 2 has 2 technical reserves fields. Field 2-1 (with 12mmboe of oil) is less than 5km from Broom, less than 10km from Heather and less than 25km from Pelican, Lyell, Cheviot and field 2-2. Field 2-2 (with 6.15mmboe of oil and a very small amount of gas) is less than 10km from Cheviot and less than 25km from Ninian, Pelican, field 2-1, field 3-4, field 3-5, field 3-10 and field 3-11.

The combined expected reserves of fields 2-1 and 2-2 are 18.15mmboe. Field 2-1 fails the RNPV/I @10% >0.3 hurdle at $50/bbl and 35p/therm, and $60/bbl and 40p/therm, but it passes at $70/bbl and 60p/therm. It fails the RNPV/I @10%

>0.5 (high hurdle) at all prices on a stand-alone basis. Field 2-2 fails both hurdles at all prices on a stand-alone basis. On a stand-alone basis only 12mmboe are produced economically with a $70/bbl and 60p/therm price and the base hurdle with RNPV @ 10% of £71.54m. As a cluster project (2-1a) it would pass the base hurdle at $70/bbl and 60p/therm producing 18.15mmboe and attaining RNPV @ 10% of £111.22m. Both reserves produced and RNPV @ 10% are higher with a hub development. The results are shown in Table 9.

Table 9

Results for Stand-Alone and Cluster Developments in Quad 2 with Field 2-1a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
2-1a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					18.15	18.15	-68.01	-42.07
$50/bbl 35p/therm high					18.15	18.15	-68.01	-42.07
$60/bbl 40p/therm base					18.15	18.15	27.74	43.32
$60/bbl 40p/therm high					18.15	18.15	27.74	43.32
$70/bbl 60p/therm base	12	18.15	71.54	111.22	6.15		35.65	
$70/bbl 60p/therm high					18.15	18.15	107.19	111.22

In Table 9 it is seen that the total reserves recovered are apparently the same at all three oil prices shown. This reflects the rounding of the results. The aggregate recovery is slightly higher the higher the price, but the production decline rate is steep, generally at 20%.

2) Quadrant 3

Quadrant 3 has 21 technical reserves fields. Field 3-1 (with 1.34mmboe of oil) is less than 10km from Lyell, Ninian or field 211-12 and less than 25km from Pelican, Strathspey, Cormorant, Darwin, field 3-2, field 3-3, field 211-8 or field 211-13.

Field 3-2 (with 4.14mmboe of oil) is within 5km of Ninian, within 10km of Alwyn North, Strathspey or field 3-3 and less than 25km from field 3-1, field 3-5, field 3-6, field 3-7, field 3-8, field 3-9, field 211-12 or field 211-13.

Field 3-3 (with 5mmboe of oil) is less than 5 km from Alwyn North, less than 10km from field 3-8 or field 3-9 and less than 25km away from field 3-1, field 3-5, field 3-6, field 3-7 or field 211-13.

Field 3-4 (with 4.31mmboe of oil) is less than 5km from field 3-5, 10km from Ninian, field 3-6 or field 3-10 and less than 25km from Dunbar, Cheviot, field 3-11 or field 2-2.

Field 3-5 (with 18mmboe of oil) is less than 5km from Ninian or field 3-4, less than 10km from field 3-6 and it is less than 25km from Dunbar, Cheviot, field 3-2, field 3-3, field 3-7, field 3-10, field 3-11 or field 2-2.

Field 3-6 (with 2.34mmboe of oil) is less than 5 km from Ninian, less than 10km from Dunbar, field 3-4 or field 3-5, and less than 25km from Alwyn North, field 3-2, field 3-3, field 3-7, field 3-8 or field 3-9.

Field 3-7 (with 10mmboe of gas) is less than 5 km from Alwyn North, less than 10km from Dunbar, field 3-8 or field 3-9, and less than 25km from Ninian, field 3-2, field 3-3, field 3-5, field 3-6field 3-12 or field 3-13.

Field 3-8 (with 4.87mmboe of oil and gas) is less than 5 km from Alwyn North or field 3-9, less than 10km from field 3-3 or field 3-7 and less than 25km from Dunbar, field 3-2 or field 3-6.

Field 3-9 (with 15.03mmboe of gas condensate) is less than 5 km from Alwyn North or field 3-8, less than 10km from field 3-3 or field 3-7 and less than 25km from Dunbar, field 3-2 or field 3-6.

Fields 3-9, 3-2, 3-3, 3-6, 3-7 and 3-8 on a stand-alone basis all fail both hurdles at all prices, but, with 3-9 as cluster it passes the base hurdle at $70/bbl and 60p/therm giving 41.88mmboe and attaining an RNPV @ 10% of £250.15m. Although the hub ceases production before all reserves are produced it is the only option which passes a hurdle rate. Field 3-9 is less than 15km from the FLAGS pipeline and less than 10km from the Frigg pipeline. Field 3-9 is less than 10km from the Ninian pipeline and less than 25km from the Brent pipeline.

Table 10

Results for Stand-Alone and Cluster Developments with Field 3-9 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
3-9	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					42.03	41.38	-276.32	-35.53
$50/bbl 35p/therm high					42.03	41.38	-276.32	-35.53
$60/bbl 40p/therm base					42.18	41.38	-124.81	83.70
$60/bbl 40p/therm high					42.18	41.38	-124.81	83.70
$70/bbl 60p/therm base		41.88		250.15	42.91		140.83	
$70/bbl 60p/therm high					42.91	41.88	140.83	250.15

Field 3-10 (with 9.03mmboe of oil with a small amount of gas) is less than 10km from Cheviot, field 3-4 or field 3-11, less than 25km from field 3-2, field 3-5, field 3-6, field 3-14, field 3-15, field 3-16 or field 2-2, and is less than 30km from Ninian and Dunbar.

Field 3-11 (with 5mmboe of oil) is less than 5km from Cheviot, less than 10km from field 3-10, less than 25km from field 3-2, field 3-4, field 3-5, field 3-14, field 3-15 or field 2-2, less than 30km from Ninian and less than 35km from Dunbar.

With field 2-1b as a hub the combined reserves of fields 2-2, 2-1, 3-4, 3-5, 3-10 and 3-11 give reserves of 54.5mmboe, and, if field 3-6 (which is less than 30km from field 2-2) is included, the reserves rise to almost 56.84mmboe. Field 2-2, 3-4, 3-10, 3-11 and 3-6 fail both hurdles at all prices Field 2-1 passes the base hurdle at $70/bbl and 60p/therm on a stand-alone basis giving 12mmboe as does field 3-5 giving 18mmboe. As a joint development hub 2-1b passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm, and also passes the high hurdle at $70/bbl and 60p/therm giving 54.5mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £185.98m, and as a cluster it could attain a RNPV @ 10% of £279.06m or £447.24m with the $60 and $70 prices respectively. Although 2 individual fields pass the base hurdle at $70/bbl and 60p/therm the reserves produced by the cluster and the RNPV @ 10% are higher.

Table 11

Results for Stand-Alone and Cluster Developments with Field 2-1b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
2-1b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					54.50	54.50	-217.81	101.61
$50/bbl 35p/therm high					54.50	54.50	-217.81	101.61
$60/bbl 40p/therm base		54.50		279.06	54.50		60.79	
$60/bbl 40p/therm high					54.50	54.50	60.79	279.06
$70/bbl 60p/therm base	30	54.50	185.98	447.24	24.50		115.66	
$70/bbl 60p/therm high		54.50		447.24	54.50		301.64	

Hub 2-1c passes both hurdles at $70/bbl and 60p/therm and the base hurdle at $60/bbl and 40p/therm giving 56.84mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £185.98m while the cluster gives RNPV@10% of £303m at $60 and £476.78m at $70. Although 2 fields pass the base hurdle at $70/bbl and 60p/therm the reserves produced by the cluster and the RNPV @ 10% are higher. The cluster passes the base hurdle at $60/bbl and 40p/therm. Field 2-2 is 25km from the FLAGS pipeline. There is only 0.72mmboe of gas in this cluster. Field 2-2 is less than 10km from the Ninian pipeline and less than 30km from the Brent pipeline.

Table 12

Results for Stand-Alone and Cluster Developments with Field 2-1c as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
2-1c	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					56.84	56.84	-217.81	118.73
$50/bbl 35p/therm high					56.84	56.84	-217.81	118.73
$60/bbl 40p/therm base		56.84		303.00	56.84		60.79	
$60/bbl 40p/therm high					56.84	56.84	60.79	303.00
$70/bbl 60p/therm base	30.00	56.84	185.98	476.78	26.84		115.66	
$70/bbl 60p/therm high		56.84		476.78	56.84		301.64	

Field 3-12 (with 2mmboe of oil) is less than 5km from Islay, Forvie or field 3-13, less than 10km from Ellon or Dunbar and less than 25km from Alwyn North, field 3-7 or field 3-16.

Field 3-13 (with 6mmboe of oil) is less than 5km from Islay, Forvie or field 3-12, less than 10km from Nuggets and less than 25km from Ellon, Dunbar, field 3-7, field 3-16 or field 3-17.

Field 3-14 (with 4mmboe of oil) is less than 25km from field 3-10, field 3-11, field 3-15 or field 3-16, less than 30km from Cheviot, and less than 35km from Nuggets or Dunbar.

Field 3-15 (with 15mmboe of oil) is less than 10km from field 3-16, less than 25km from Nuggets, Dunbar, field 3-10, field 3-11, field 3-14 or field 3-17 and less than 30km from Cheviot.

Field 3-16 (with 49.16mmboe of oil) is less than 10km from field 3-15 and less than 25km from Nuggets, Dunbar, Forvie, field 3-10, field 3-12, field 3-13, field 3-14 and field 3-17.

Field 3-17 (with 2mmboe of oil) is less than 25km from Nuggets, Dunbar, field 3-13, field 3-15, field 3-16 and field 3-18.

With field 3-16 as a hub the combined reserves of fields 3-12, 3-13, 3-14, 3-15 and 3-17 are 78.16mmboe. Field 3-10 could also access this hub if it is not used in another increasing the reserves to 87.19mmboe. Field 3-16 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and it passes the higher hurdle at $70/bbl and 60p/therm giving 49.16mmboe. Fields 3-12, 3-13, 3-14 and 3-17 fail both hurdles at all prices on a stand-alone basis as does field 3-10. Field 3-15 passes the base hurdle at $70/bbl and 60p/therm giving 15mmboe. Hub 3-16a passes both hurdles at $60/bbl and 40p/therm and $70/bbl and 60p/therm giving 78.16mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £238.31m at $60/bbl and 40p/therm, and £482.48m or

£386.11m at $70/bbl and 60p/therm. As a cluster it could attain RNPV @ 10% of £428.42m at $60/bbl and 40p/therm or £629.61m at $70/bbl and 60p/therm.

Table 13

Results for Stand-Alone and Cluster Developments with Field 3-16a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
3-16a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					78.16	78.16	-32.82	236.46
$50/bbl 35p/therm high					78.16	78.16	-32.82	236.46
$60/bbl 40p/therm base	49.16	78.16	238.31	428.42	29.00		29.85	
$60/bbl 40p/therm high		78.16		428.42	78.16		268.16	
$70/bbl 60p/therm base	64.16	78.16	482.48	629.61	14.00		64.06	
$70/bbl 60p/therm high	49.16	78.16	386.11	629.61	29.00		160.43	

The cluster with hub 3-16b passes the base hurdle at all prices and the higher hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm giving 87.19mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £238.31m at $60/bbl and 40p/therm and £482.48m or £386.11m at $70/bbl and 60p/therm. As a cluster it could attain RNPV @ 10% of £320.10m at $50/bbl and 35p/therm, £523.49m at $60/bbl and 40p/therm or £745.92m at $70/bbl and 60p/therm. Field 3-16 is less than 20km from the FLAGS pipeline and less than 15km from the Frigg

pipeline but the cluster has only 0.53mmboe of gas. Field 3-16 is 45km from the Ninian pipeline.

Table 14

Results for Stand-Alone and Cluster Developments with Field 3-16b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
3-16b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base		87.19		320.10	87.19		-88.99	
$50/bbl 35p/therm high					87.19	87.19	-88.99	320.10
$60/bbl 40p/therm base	49.16	87.19	238.31	523.49	38.03		38.88	
$60/bbl 40p/therm high		87.19		523.49	87.19		277.20	
$70/bbl 60p/therm base	64.16	87.19	482.48	745.92	23.03		97.60	
$70/bbl 60p/therm high	49.16	87.19	386.11	745.92	38.03		169.46	

Field 3-18 (with 6.05mmboe of oil and gas) is less than 10km from Rhum, less than 25km from Nuggets, field 3-17, field 3-20, field 3-21 or field 4-1 and less than 35km from Frigg.

Field 3-19, a heavy oil field (with 71.9mmboe of oil), is less than 10km from Kraken, and less than 25km from Rhum. Field 3-19 could stand-alone but it fails the hurdles at all prices. There are no oil pipelines near field 3-19.

Field 3-20 (with 5.63mmboe of gas) is less than 5km from field 4-1, 10km from field 3-21 and less than 25km from Rhum or field 3-18.

Field 3-21 (with 1.94mmboe gas) is less than 10km from Rhum, field 3-20 or field 4-1 and is less than 25km from Frigg or field 3-18.

3) Quadrant 4

Quadrant 4 has 1 gas field (with 29.7mmboe) which is less than 5km from field 3-20, less than 10 km from field 3- 21 and less than 25km from Rhum or field 3-18.

With field 4-1 as a hub the combined reserves of fields 3-18, 3-20 and 3-21 give 43.33mmboe. On a stand-alone basis at all prices fields 4-1, 3-18, 3-20 and 3-21 fail the hurdle rates. The cluster with hub 4-1 also fails the hurdles at all prices. Field 4-1 is less than 5km from the Frigg pipeline. There are only 2mmboe of oil in this cluster but there are no nearby oil pipelines.

Table 15

Results for Stand-Alone and Cluster Developments with Field 4-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
4-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					43.56	43.33	-385.73	-235.56
$50/bbl 35p/therm high					43.56	43.33	-385.73	-235.56
$60/bbl 40p/therm base					43.86	43.33	-298.60	-157.96
$60/bbl 40p/therm high					43.86	43.33	-298.60	-157.96
$70/bbl 60p/therm base					44.46	43.33	17.30	103.77
$70/bbl 60p/therm high					44.46	43.33	17.30	103.77

4) Quadrant 8

Quadrant 8 has 2 technical reserves fields. Field 8-1 (with 36mmboe of oil) is less than 5km to Mariner, a large heavy oil field, or field 8-2, and less than 25km to Nevis, Beryl, field 9.3, field 9.4, field 9.5, field 9.6, field 9-7, field 9-8 or field 9.19.

Field 8-2 (with 18mmboe of oil) is less than 5km to Mariner or field 8-1, less than 25km to Nevis, field 9.3, field 9.4, field 9.5, field 9.6, field 9-7, field 9-8 or field 9-19, less than 30km to Beryl and less than 35km to Kraken.

5) Quadrant 9

Quadrant 9 has 24 technical reserves fields. Field 9-1 (with 1.41mmboe of gas) is less than 5km to Bruce or field 9-2, less than 10km to Boa and field 9-9, and less than 25km to Beryl, Keith and field 9-10.

Field 9-2 (with 8.6mmboe of gas) is less than 5km to Bruce or field 9-1 and less than 25km to Frigg, Beryl, Keith, field 9-9 or field 9-10.

Field 9-3 (with 12.17mmboe of oil) is less than 5km to Mariner or field 9-5, less than 10km to field 9-4 or field 9-6 less than 25km to Nevis, Beryl, field 8-1, field 8-2, field 9-7, field 9-8, field 9-11, field 9-12, or field 9-19.

Field 9-4 (with 8.22mmboe of oil) is less than 5km to field 9-5, less than 10km to Mariner, Nevis, field 9-3, field 9-6, field 9-7 or field 9-8 and less than 25km to Beryl, field 9-11, field 9-12, field 9-19, field 8-1, and field 8-2.

Field 9-5 (with 2.02mmboe of oil) is less than 5km to Mariner, field 9-3 or field 9-4, less than 10km to Nevis, field 9-6, field 9-7 or field 9-8 and less than 25km to Beryl, field 9-11, field 9-12, field 9-13, field 9-19, field 8-1, or field 8-2.

Field 9-6 (with 3.81mmboe of oil) is less than 5km from Nevis, less than 10km from Beryl, field 9-3. Field 9-4, field 9-5, field 9-7 or field 9-8 or less than 25km from Mariner, field 9-11, field 9-12, field 9-13, field 9-17, field 9-19, field 8-1 or field 8-2.

Field 9-7 (with 22.69mmboe of oil and gas) is less than 5km from Nevis, Ness, Beryl or field 9-8, less than 10km from field 9-4, field 9-5 or field 9-6 and less than 25km from Mariner, field 9-3, field 9-10, field 9-11, field 9-12, field 9-13, field 9-14, field 9-17, field 9-19, field 8-1, or field 8-2.

Field 9-8 (with 54.1mmboe of gas condensate) is less than 5km from Nevis, Ness, Beryl or field 9-7, less than 10km to field 9-4, field 9-5, or field 9-6 and less than 25km from Mariner, field 9-3, field 9-10, field 9-11, field 9-12, field 9-13, field 9-14, field 9-17, field 9-19, field 8-1, or field 8-2.

Field 9-9 (with 18.46mmboe of oil and gas) is less than 5km from Boa, less than 10km from field 9-1 or field 9-10, less than 25km from Bruce, Keith, Beryl, field 9-2, or field 9-4.

Field 9-10 (with 1.82mmboe of oil) is less than 5km from Boa, less than 10km from field 9-9 and less than 25km from Bruce, Keith, Beryl, Callater, field 9-1, field 9-2, field 9-7, field 9-8, field 9-11, field 9-12, field 9-13, field 9-14, field 9-15, field 9-16, field 9-17, and field 9-18.

Field 9-11 (with 2.48mmboe of oil) is less than 5km from, Buckland, Beryl, field 9-12 or field 9-13, less than 10km from Nevis, field 9-14, field 9-15 or field 9-17 and less than 25km from field 9-3, field 9-4, field 9-5, field 9-6, field 9-7, field 9-8, field 9-10, field 9-16, field 9-18, field 9-19, field 9-21, or field 9-22.

Field 9-12 (with 2.65mmboe of gas) is less than 5km from Buckland, field 9-11, field 9-13 or field 9-17, less than 10km from Beryl, Skene, Gryphon, field 9-14 or field 9-15 and less than 25km from field 9-3, field 9-4, field 9-5, field 9-6, field 9-7, field 9-8, field 9-10, field 9-16, field 9-18, field 9-19, field 9-20, field 9-21, or field 9-22.

Field 9-13 (with 2.94mmboe of oil and a small amount of gas) is less than 5km from field 9-11, field 9-12 or field 9-17, less than 10km from Buckland, Skene, Gryphon, field 9-14 or field 9-15 and less than 25km from field 9-5, field 9-6, field 9-7, field 9-8, field 9-10, field 9-16, field 9-18, field 9-19, field 9-20, field 9-21, or field 9-22.

Field 9-14 (with 10mmboe of oil) is less than 5km from Skene, Callater, field 9-15 or field 9-16, less than 10km from Maclure, Buckland, field 9-11, field 9-12, field 9-13, field 9-17 or field 9-18 and less than 25km from field 9-7, field 9-8, field 9-9, field 9-10, field 9-13, field 9-21, or field 9-22.

With field 9-9 as a hub the combined reserves of fields 9-1, 9-2 and 9-10 are 30.29mmboe and, if field 9-14 is included, the reserves rise to 40.29mmboe. Fields 9-9, 9-1, 9-2, 9-10 and 9-14 individually fail both hurdles at all prices. The cluster with hub 9-9a fails both hurdles at all prices but passes the base hurdle at $70/bbl and 60p/therm giving 40.78mmboe. As a cluster 9-9b could attain a RNPV @ 10% of £214.43m at $70/bbl and 60p/therm. It produces less than the stand-alone fields but it does pass the base hurdle at $70/bbl and 60p/therm. Field 9-9 is less than 15km from the Frigg pipeline and less than 25km from the SAGE pipeline. There are no nearby oil pipelines.

Table 16

Results for Stand-Alone and Cluster Developments with Field 9-9a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
9.9a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					30.40	30.29	-224.38	-160.60
$50/bbl 35p/therm high					30.40	30.29	-224.38	-160.60
$60/bbl 40p/therm base					30.83	30.29	-145.53	-93.05
$60/bbl 40p/therm high					30.83	30.29	-145.53	-93.05
$70/bbl 60p/therm base					31.07	30.78	60.24	80.83
$70/bbl 60p/therm high					31.07	30.78	60.24	80.83

Table 17

Results for Stand-Alone and Cluster Developments with Field 9-9a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
9.9b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					40.79	40.29	-264.27	-72.97
$50/bbl 35p/therm high					40.79	40.29	-264.27	-72.97
$60/bbl 40p/therm base					41.29	40.29	-130.73	37.79
$60/bbl 40p/therm high					41.29	40.29	-130.73	37.79
$70/bbl 60p/therm base		40.78		214.43	41.53		116.33	
$70/bbl 60p/therm high					41.53	40.78	116.33	214.43

Field 9-15 (with 18mmboe of gas) is less than 5km from Skene, Maclure, field 9-14, field 9-16, field 9-17 or field 9-18, less than 10km from field 9-12 or field 9-13. and less than 25km from Buckland, Beryl, field 9-10, field 9-20, field 9-21 or field 9-22.

Field 9-16 (with 9.54mmboe of oil with a little gas) is less than 5km from Skene, Maclure, field 9-14, field 9-15, field 9-17 or field 9-18 and less than 25km from Buckland, Beryl, field 9-10, field 9-11, field 9-12, field 9-13, field 9-20, field 9-21 or field 9-22.

Field 9-17 (with 10mmboe of oil) is less than 5km to Skene, Maclure, Callater, field 9-12, field 9-13, field 9-15 or field 9-16, less than 10km from Buckland, field 9-11, field 9-14 or field 9-18 and less than 25km from field 9-6, field 9-7, field 9-8, field 9-10, field 9- 20, field 9-21, or field 9-22.

Field 9-18 (with 2mmboe of gas) is less than 5km from field 9-15 or field 9-16, less than 10km from Skene, Maclure, field 9-14 or field 9-17 and less than 25km from field 9-10, field 9-11, field 9-12, field 9-13, field 9-20, field 9-21, or field 9-22.

Field 9-19 (with 15mmboe of oil) is less than 25km from Mariner, Buckland, Nevis, field 9-3, field 9-4, field 9-5, field 9-6, field 9-7, field 9-8, field 9-11, field 9-12, field 9-13, field 9-21, field 9-22, field 8-1, or field 8-2.

With field 9-8 as a hub the combined reserves of fields 9-3, 9-4, 9-5, 9-6, 9-7, 9-11, 9-12, 9-13, 9-14, 9-17 and 9-19 are 146.08mmboe, and, if fields 8-1 and 8-2 are included, the reserves rise to 200.08mmboe. Field 9-8 passes the base hurdle at $70/bbl and 60p/therm giving 53.29mmboe. Field 9-3 passes the base hurdle at $70/bbl and 60p/therm giving 12.17mmboe. Field 9-19 passes the base hurdle at $70/bbl and 60p/therm giving 15mmboe. Fields 9-4, 9-5, 9-6, 9-7, 9-11, 9-12, 9-13, 9-14 and 9-17 fail both hurdles at all prices. The cluster with hub 9-8a passes both hurdles at all prices giving 146.08mmboe. On a stand-alone basis these fields attain an RNPV @ 10% of £481.72m at $70/bbl and 60p/therm, and as a cluster RNPV @ 10% of £660.89m at $50/bbl and 35p/therm, £962.38m at $60/bbl and 40p/therm, and £1330.79m at $70/bbl and 60p/therm. Although 3 fields pass the base hurdle at $70/bbl and 60p/therm the reserves produced, and the RNPV @ 10% are higher with the cluster which passes both hurdles at all prices.

Table 18

Results for Stand-Alone and Cluster Developments with Field 9-8a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
9-8a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base		146.08		660.89	144.06		-513.35	
$50/bbl 35p/therm high		146.08		660.89	144.06		-513.35	
$60/bbl 40p/therm base		146.08		962.38	145.83		96.77	
$60/bbl 40p/therm high		146.08		962.38	145.83		96.77	
$70/bbl 60p/therm base	80.46	146.08	481.72	1330.79	65.37		238.20	
$70/bbl 60p/therm high		146.08		1330.79	145.83		719.92	

Fields 8-1 and 8-2 pass the base hurdle at $70/bbl and 60p/therm giving 36mmboe and 18mmboe respectively. The cluster with hub 9-8b passes both hurdles at both prices giving 200.08mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £822.91m at $70/bbl and 60p/therm, and as a cluster RNPV @ 10% of £1041.18m at $50/bbl and 35p/therm, £1467.21.72m at $60/bbl and 40p/therm, and £1958.09m at $70/bbl and 60p/therm. Field 9-8 is less than 5km from the Frigg pipeline or the SAGE pipeline. There are no nearby oil pipelines.

Table 19

Results for Stand-Alone and Cluster Developments with Field 9-8b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
9-8b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base		200.08		1041.18	198.06		-564.01	
$50/bbl 35p/therm high		200.08		1041.18	198.06		-564.01	
$60/bbl 40p/therm base		200.08		1467.21	199.83		266.72	
$60/bbl 40p/therm high		200.08		1467.21	199.83		266.72	
$70/bbl 60p/therm base	134.46	200.08	822.91	1958.09	65.37		238.20	
$70/bbl 60p/therm high		200.08		1958.09	199.83		1061.11	

Field 9-20 (with 15mmboe of oil) is less than 5km from Morrone or Devenick, less than 10km to Harding or field 9-23, and less than 25km to field 9-12, field 9-13, field 9-15, field 9-16, field 9-17, field 9-18, field 9-21, field 9-22, or field 9-24.

Field 9-21, which is an HPHT field, (with 12.05mmboe of oil and gas) is less than 5km from Harding, Gryphon or field 9-22, less than 10km from field Maclure and less than 25km from Buckland, field 9-11, field 9-12, field 9-13, field 9-14, field 9-15, field 9-16, field 9-17, field 9-18, field 9-19, field 9-20, or field 9-23.

Field 9-22 (with 4.31mmboe of gas) is less than 5km from Harding, Gryphon or field 9-21, less than 10km from Maclure and less than 25km from Buckland, field 9-11, field 9-12, field 9-13, field 9-14, field 9-15, field 9-16, field 9-17, field 9-18, field 9-19, field 9-20, or field 9-23.

With field 9-15 as a hub the combined reserves of fields 9-16, 9-18, 9-20, 9-21 and 9-22 give 60.91mmboe. Fields 9-15, 9-16, 9-18, 9-21 and 9-22 individually fail both hurdles at both prices. Field 9-20 passes the base hurdle at $70/bbl and 60p/therm giving 15mmboe. The cluster with hub 9-15 fails both hurdles at $50/bbl and 35p/therm and $60/bbl and 40p/therm, but passes the base hurdle at $70/bbl and 60p/therm giving 60.92mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £101.79m at $70/bbl and 60p/therm. As a cluster the RNPV @ 10% is £226.49m. The hub ceases production earlier than the stand-alone fields. Field 9-5 is less than 20km from the SAGE pipeline and less than 35km from the Frigg pipeline. There are no nearby oil pipelines.

Table 20

Results for Stand-Alone and Cluster Developments with Field 9-15 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
9-15	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					60.42	59.09	-402.15	-183.95
$50/bbl 35p/therm high					60.42	59.09	-402.15	-183.95
$60/bbl 40p/therm base					61.11	60.92	-180.79	-7.69
$60/bbl 40p/therm high					61.11	60.92	-180.79	-7.69
$70/bbl 60p/therm base	15.00	60.92	101.79	226.49	46.11		74.26	
$70/bbl 60p/therm high					61.11	60.92	176.04	226.49

Field 9-23 (with 27.1mmboe of oil with a little gas) is less than 5km from Devenick, less than 10km from Morrone, Harding or field 9-20 and less than 25km from Braemar, field 9-21, field 9-22, field 9-24, or field 16-3.

Field 9-24 (with 15mmboe of oil) is less than 5km from Braemar and less than 25km from Devenick, Beinn, East Brae, field 9-20, field 9-23, field 16-1, field 16-2, field 16-3, or field 16-6.

6) Quadrant 11

Quadrant 11 has one technical reserve field (with 2mmboe of oil) which is less than 25km from field 12-1, field 12-2 and field 12-5.

7) Quadrant 12

Quadrant 12 has 7 technical reserves fields. Field 12-1 (with 2.71mmboe of oil) is less than 5km from field 12-5 and less than 25km from field 11-1, or field 12-2.

Field 12-2 (with 8.81mmboe of oil) is less than 25km from field 11-1, field 12-1 or field 12-5.

Field 12-3 (with 1mmboe of oil) is less than 5km from field 13-2, less than 10km from field 12-4 or field 12-7 and less than 25km from Captain, field 12-6, field 13-3, or field 13-7.

Field 12-4 (with 2mmboe of oil) is less than 5km from field 13-2, less than 10km from Captain or field 12-3 and less than 25km from field 12-7, or field 13-3.

Field 12-5 (with 2mmboe of oil) is less than 5km from field 12-1 and less than 25km from field 12-2, or field 11-1.

With field 12-2 as a hub the combined reserves of fields 11-1, 12-1 and 12-5 give 15.57mmboe. Fields 12-2, 11-1, 12-1 and 12-5 fail both hurdles at all prices. The cluster with hub 12-2 passes the base hurdle at $70/bbl and 60p/therm giving 15.57mmboe. As a cluster it could attain RNPV @ 10% of £116m at $70/bbl and 60p/therm. This hub consists of oil only and the only pipeline in the area is the Beatrice pipeline which is connected to Nigg. Beatrice is being decommissioned with the decommissioned pipeline left in place.

Table 21

Results for Stand-Alone and Cluster Developments with Field 12-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
12-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					15.57	15.57	-124.38	3.84
$50/bbl 35p/therm high					15.57	15.57	-124.38	3.84
$60/bbl 40p/therm base					15.74	15.57	-39.59	66.92
$60/bbl 40p/therm high					15.74	15.57	-39.59	66.92
$70/bbl 60p/therm base		15.57		116.00	15.74		40.62	
$70/bbl 60p/therm high					15.74	15.57	40.62	116.00

Field 12-6 (with 14.13mmboe of oil and gas) is less than 25km from field 12-3, or field 12-7.

Field 12-7 (with 44.03mmboe of oil) is less than 10km from field 12-3 and less than 25km from field 12-4, field 12-6, field 13-2, or field 13-7.

8) Quadrant 13

Quadrant 13 has 8 technical reserves fields. The exact co-ordinates of field 13-1 (with 19.5mmboe of oil and gas) are unknown but there could only be 1 of 2 wells in the block and neither are near any existing fields or other discoveries. Field 13-1 passes the base hurdle at $70/bbl and 60p/therm giving 19.37mmboe. Field

13-1 is less than 25km from the Claymore/Flotta pipeline or 40km to the FLAGS pipeline.

Field 13-2 (with 6.4mmboe of oil) is less than 5km from field 12-3 or field 12-4, less than 25km from Captain, field 12-7, field 13-3, or field 13-7.

Field 13-3 (with 8.59mmboe of gas condensate) is less than 10km from Captain and less than 25km from Blake, Ross, field 12-2, field 12-4, field 13-2, field 13-4, field 13-5, or field 13-7.

Field 13-4 (with 2.35mmboe of oil with a little gas) is less than 10km from Blake, Ross, or field 13-5 and less than 25km from Captain, field 13-3, or field 13-6.

Field 13-5 (with 15mmboe of oil) is less than 5km from field Blake, less than 10km from field 13-4 and less than 25km from Captain, Ross, field 13-3, or field 13-6.

Field 13-6 (with 7.74mmboe of gas with a little oil) is less than 10km from Blake, less than 25km from Ross, field 13-4, field 13-5, field 13-8 or field 14-9 and less than 30km from Golden Eagle.

With field 13-5 as a hub the combined reserves of fields 13-3, 13-4 and 13-6 give 33.68mmboe. Fields 13-3, 13-4 and 13-6 fail all hurdles at both prices. Field 13-5 passes the base hurdle at $70/bbl and 60p/therm giving 15mmboe. The cluster with 13-5 hub fails both hurdles at all prices. On a stand-alone basis the passing fields attain RNPV @ 10% of £112.58m at $70/bbl and 60p/therm, but the cluster fails the hurdle. But the NPVs@10% for the cluster development at $70, 60 pence are significantly positive. Field 13-5 is less than 15km from the FLAGS pipeline

and less than 35km from the Frigg pipeline. The nearest oil pipeline is the Golden Eagle/Claymore link which is 50km away.

Table 22

Results with Stand-Alone and Cluster Developments with Hub 13-5

	mmboe		RNPV @10%		mmboe		RNPV @10%	
13-5	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					33.52	30.99	-187.53	-187.93
$50/bbl 35p/therm high					33.52	30.99	-187.53	-187.93
$60/bbl 40p/therm base					34.07	33.69	-65.21	-71.32
$60/bbl 40p/therm high					34.07	33.69	-65.21	-71.32
$70/bbl 60p/therm base	15.00		112.58		19.07	33.69	11.38	90.62
$70/bbl 60p/therm high					34.07	33.69	123.96	90.62

Field 13-7 (with 37mmboe of oil and gas) is less than 25km from Ross, field 12-3, field 12-7, field 13-2, or field 13-3.

With field 12-7 as a hub the combined reserves of fields 12-3, 12-4, 12-6, 13-2 and 13-7 give 104.57mmboe. Field 12-7 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and it passes the higher hurdle at $70/bbl and 60p/therm giving 44.03mmboe. Fields 12-3, 12-4, 12-6, 13-2 and 13-7 fail both hurdles at all prices. The cluster with hub 12-7 passes the base hurdle at $70/bbl and 60p/therm giving 104.57mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £186.73m at $60/bbl and 40p/therm and £322.18m at

$70/bbl and 60p/therm. As a cluster it could attain RNPV @ 10% of £539.82m at $70/bbl and 60p/therm. Field 12-7 is 45km from the FLAGS pipeline but there are no nearby oil pipelines.

Table 23

Results with Stand-Alone and Cluster Developments with Field 12-7 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
12-7	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					102.19	104.57	-251.29	-83.66
$50/bbl 35p/therm high					102.19	104.57	-251.29	-83.66
$60/bbl 40p/therm base	44.03		186.73		61.91	104.57	-83.94	201.58
$60/bbl 40p/therm high					105.94	104.57	102.79	201.58
$70/bbl 60p/therm base	44.03	104.57	322.18	539.82	61.91		235.85	
$70/bbl 60p/therm high	44.03		322.18		61.91	104.57	235.85	539.82

Field 13-8 (with 8mmboe of oil) is less than 10km from Golden Eagle, Solitaire, or field 14-8, and less than 25km from Ross, Blake, Peregrine, Buzzard, Ettrick, field 13-6, field 14-9, or field 14-10.

9) Quadrant 14

Quadrant 14 has 12 technical reserves fields. Field 14-1 (with 10.15mmboe of oil) is less than 10km from Claymore and less than 25km from Scapa, field 14-2, field 14-3, field 14-4, field 14-5, field 14-6, or field 14-7.

Field 14-2 (with 8.84mmboe of oil and gas) is less than 5km from field 14-7, less than 10km from Claymore and less than 25km from Scapa, Piper, Tartan, field 14-1, field 14-6, field 15-2, or field 15-7.

Field 14-3 (with 6.18mmboe of oil and very little gas) is less than 5km from field 14-5 or field 14-6, less than 10km from Claymore, Scapa or field 14-4 and less than 25km from Highlander, or field 14-1.

Field 14-4 (with 12.36mmboe of oil) is less than 5km from field 14-5, less than 10km from Scapa, field 14-3 or field 14-6 and less than 25km from Claymore, or field 14-1.

Field 14-5 (with 8.48mmboe of oil with very little gas) is less than 5km from field 14-3 or field 14-4, less than 10km from Scapa or field 14-6 and less than 25km from Claymore, or field 14-1.

Field 14-6 (with 48.96mmboe of oil) is less than 5km from Scapa, Claymore or field 14-3, less than 10km from field 14-4 or field 14-5 and less than 25km from field 14-1, field 14-2, or field 14-7.

Field 14-7 (with 25.32mmboe of oil) is less than 5km from field 14-2, less than10km from Highlander or Claymore and less than 25km from Tartan, Piper, field 14-1, field 14-6, field 15-2, or field 15-7.

With field 14-6 as a hub the combined reserves of fields 14-1, 14-2, 14-3, 14-4, 14-5 and 14-7 give 120.29mmboe. Field 14-6 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and the higher hurdle at $70/bbl and 60p/therm giving 48.96mmboe. Fields 14-1, 14-2, 14-3 and 14-5 fail both hurdles at all prices. Field 14-4 passes the base hurdle at $70/bbl and 60p/therm giving

12.36mmboe, as does field 14-7 giving 25.32mmboe. The cluster with hub 14-6 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and the higher hurdle at $70/bbl and 60p/therm giving 120.29mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £210.13m at $60/bbl and 40p/therm and £560.08m or £344.37m at $70/bbl and 60p/therm. As a cluster it could attain RNPV @ 10% of £533.87m at $60/bbl and 40p/therm or £809.12m at $70/bbl and 60p/therm. Field 14-6 is just over 10km from the Frigg pipeline and less than 10km from the Golden Eagle/Claymore pipeline. There is less than 4mmboe of gas in this cluster.

Table 24

Results with Stand-Alone and Cluster Developments with Field 14-6 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
14-6	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					120.29	120.29	-291.93	191.97
$50/bbl 35p/therm high					120.29	120.29	-291.93	191.97
$60/bbl 40p/therm base	48.96	120.29	210.13	533.87	71.33		1.43	
$60/bbl 40p/therm high					120.29	120.29	211.57	533.87
$70/bbl 60p/therm base	86.64	120.29	560.08	809.12	33.65		86.60	
$70/bbl 60p/therm high	48.96	120.29	344.37	809.12	71.33		302.31	

Field 14-8 (with 3mmboe of oil) is less than 5km from field 14-10, less than 10km from Solitaire, Peregrine, field 14-9 or field 13-8 and less than 25km from Buzzard.

Field 14-9 (with 1mmboe of oil) is less than 10km from field 14-8 or field 14-10 and less than 25km from Solitaire, Peregrine, Ross, Blake, field 13-6, or field 13-8.

Field 14-10 (with 4.93mmboe of gas) is less than 5km from field 14-8, less than 10km from Solitaire, Peregrine or field 14-9 and less than 25km from Ross, or field 13-8.

With field 13-8 as a hub the combined reserves of fields 14-8, 14-9 and 14-10 give 16.93mmboe. Fields 13-8, 14-8, 14-9 and 14-10 fail both hurdles at all prices. Hub 13-18 passes the base hurdle at $70/bbl and 60p/therm giving 16.93mmboe. As a cluster 13-8 could attain RNPV @ 10% of £86.99m at $70/bbl and 60p/therm. Field 13-8 is less than 5km from the Frigg pipeline, less than 20km from the FLAGS pipeline and around 10km from the Golden Eagle/Claymore oil pipeline. This cluster has less than 5mmboe of gas.

Table 25

Results with Stand-Alone and Cluster Developments with Field 13-8 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
13-8	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					16.92	16.93	-172.91	-58.01
$50/bbl 35p/therm high					16.92	16.93	-172.91	-58.01
$60/bbl 40p/therm base					17.12	16.93	-97.05	11.89
$60/bbl 40p/therm high					17.12	16.93	-97.05	11.89
$70/bbl 60p/therm base		16.93		86.99	17.12		9.31	
$70/bbl 60p/therm high					17.12	16.93	9.31	86.99

Field 14-11 (with 6.88mmboe of gas with a little oil) is less than 25km from Buchan, Tweedsmuir, field 14-12, field 15-19, 15-20, field 20-1, field 20-2, field 20-3, or field 20-4.

Field 14-12 (with 10.61mmboe of oil) is less than 25km from Scott, Telford, field 14-11, 15-12, 15-13, 15-14, field 15-19, 15-20, or field 15-21.

10) Quadrant 15

Quadrant 15 has 26 technical reserves fields. Field 15-1 (with 25mmboe of heavy oil) is less than 25km from field 15-2, field 15-3 or field 15-4.

Field 15-2 (with 16.24mmboe of oil and a little gas) is less than 5km from Piper or field 15-4, less than 10km from field 15-3, and less than 25km from field 15-

1, field 15-5, field 15-6, field 15-7, field 15-8, field 15-9, field 15-10, field 15-11, field 14-2, or field 14-7.

Field 15-3 (with 29.72mmboe of oil with very little gas) is less than 10km from field 15-2 or field 15-4, and less than 25km from Piper, field 15-1, field 15-5, field 15-8, field 15-9, field 15-10, or field 15-11.

Field 15-4 (with 40mmboe of oil) is less than 5km from field 15-2, less than 10km from Piper or field 15-3, and less than 25km from field 15-1, field 15-5, field 15-6, field 15-7, field 15-8, field 15-9, field 15-10, or field 15-11.

Field 15-5 (with 3mmboe of oil) is less than 5km from field 15-6 field 15-8, field 15-9 or field 15-10, less than 10km from Piper or field 15-7, and less than 25km from Scott, Tartan, field 15-2, field 15-3, field 15-4, field 15-11, field 15-12, field 15-13, field 15-14, field 15-15, field 15-16, or field 15-17.

Field 15-6 (with 45.18mmboe of oil) is less than 5km from field 15-5, less than 10km from Scott, Piper, field 15-7, field 15-8, field 15-9 or field 15-10 and less than 25km from Tartan, field 15-2, field 15-4, field 15-11, field 15-12, field 15-13, field 15-14, field 15-15, or field 15-16.

Field 15-7 (with 1.41mmboe of gas) is less than 5km from Tartan, less than 10km from Piper, field 15-5 or field 15-6 and less than 25km from Scott, field 15-2, field 15-4, field 15-8, field 15-9, field 15-10, field 15-11, field 15-12, field 15-13, field 15-14, field 15-15, field 14-2, or field 14-7.

Field 15-8 (with 4.74mmboe of oil and gas) is less than 5km from field 15-5, field 15-9 or field 15-10, less than 10km from Piper, field 15-6 or field 15-11 and less

than 25km from Dunbar, Tartan, Scott, field 15-2, field 15-3, field 15-4, field 15-7, field 15-15, field 15-16, or field 15-17.

Field 15-9 (with 2.55mmboe of oil and gas) is less than 5km from field 15-5, field 15-8 or field 15-10, less than 10km from Piper, field 15-6 or field 15-11 and less than 25km from Dunbar, Tartan, Scott, field 15-2, field 15-3, field 15-4, field 15-7, field 15-15, field 15-16, or field 15-17.

Field 15-10 (with 25.12mmboe of oil with a little gas) is less than 5km from field 15-5, field 15-8 or field 15-9, less than 10km from Piper, field 15-6 or field 15-11 and less than 25km from Dunbar, Tartan, Scott, field 15-2, field 15-3, field 15-4, field 15-7, or field 15-15.

With field 15-6 as a hub the combined reserves of fields 15-5, 15-7, 15-8, 15-9 and 15-10 are 81.99mmboe. Field 15-6 passes the base hurdle at $70/bbl and 60p/therm giving 45.18mmboe. Fields 15-5, 15-7, 15-8, 15-9 and 15-10 fail both hurdles at all prices. The cluster with hub 15-6 passes the base hurdle at $70/bbl and 60p/therm giving 81.99mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £312.02m at $70/bbl and 60p/therm, and as a cluster RNPV @ 10% of £471.31m at $70/bbl and 60p/therm. Field 15-6 is less than 20 km from the SAGE pipeline and less than 10km from the Galley/Tartan oil pipeline. This cluster has less than 7mmboe of gas.

Table 26

Results with Stand-Alone and Cluster Developments with Field 15-6 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
15-6	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					82.11	81.99	-179.41	29.42
$50/bbl 35p/therm high					82.11	81.99	-179.41	29.42
$60/bbl 40p/therm base					82.17	81.99	136.83	262.21
$60/bbl 40p/therm high					82.17	81.99	136.83	262.21
$70/bbl 60p/therm base	45.18	81.99	312.02	471.31	37.06		108.34	
$70/bbl 60p/therm high					82.24	81.99	420.37	471.31

Field 15-11 (with 4.74mmboe of oil and gas) is less than 10km from field 15-8, field 15-9 or field 15-10 and less than 25km from Dunbar, Piper, field 15-2, field 15-3, field 15-4, field 15-5, field 15-6, field 15-7, field 15-15, or field 15-18.

With field 15-4 as a hub the combined reserves of fields 15-1, 15-2, 15-3 and 15-11 give 115.7mmboe. Field 15-4 passes the base hurdle at $70/bbl and 60p/therm gives 40mmboe, as does field 15-1 giving 25mmboe, field 15-2 gives 16.24mmboe, and field 15-3 gives 29.72mmboe. Field 15-11 fails both hurdles at all prices. The cluster with hub 15-4 passes the base hurdle at $60/bbl and 40p/therm and both hurdles at $70/bbl and 60p/therm giving 115.7mmboe. On a stand-alone basis these fields attain RNPV @ 10% of £673.58m at $70/bbl and 60p/therm, and as a cluster RNPV @ 10% of £492.20m at $60/bbl and 40p/therm

or £760.45m at $70/bbl and 60p/therm. Field 15-4 is less than 10km from the SAGE pipeline and less than 15km from the Piper/Claymore link. There is less than 5mmboe of gas in this cluster.

Table 27

Results with Stand-Alone and Cluster Developments with Field 15-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
15-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					115.89	115.70	-126.49	163.62
$50/bbl 35p/therm high					115.89	115.70	-126.49	163.62
$60/bbl 40p/therm base		115.70		492.20	115.89		326.19	
$60/bbl 40p/therm high					115.89	115.70	326.19	492.20
$70/bbl 60p/therm base	110.96	115.70	673.58	760.45	4.93		17.48	
$70/bbl 60p/therm high		115.70		760.45	115.89		691.06	

Field 15-12 (with 4.2mmboe of oil) is less than 5km from Telford, Scott, field 15-13 or field 15-14, less than 25km from Piper, Tartan, Scott, Petronella, field 15-5, field 15-6, field 15-7, field 15-15, field 15-19, field 15-21, or field 14-12.

Field 15-13 (with 17.19mmboe of gas) is less than 5km from Telford, Scott, field 15-12 or field 15-14, and less than 25km from Tartan, field 15-5, field 15-6, field 15-7, field 15-15, field 15-19, field 15-21, or field 14-12.

Field 15-14 (with 1.6mmboe of oil) is less than 5km from field 15-12 or field 15-13, less than 10km from Telford or Scott and less than 25km from Tartan, field 15-5, field 15-6, field 15-7, field 15-14, field 15-19, field 15-21, or field 14-12.

Field 15-15 (with 3.99mmboe of oil with a little gas) is less than 10km from Telford, Scott or field 15-16 and less than 25km from field 15-5, field 15-6, field 15-7, field 15-8, field 15-9, field 15-10, field 15-11, field 15-12, field 15-13, field 15-14, field 15-17, field 15-19, field 15-21, field 15-22, or field 15-23.

Field 15-16 (with 10.4mmboe of oil with a little gas) is less than 5km from field 15-17, less than 10km from field 15-15 and less than 25km from Alder, Nicol, Brenda, Britannia, Telford, Scott, field 15-5, field 15-6, field 15-8, field 15-9, field 15-10, field 15-18, field 15-21, field 15-22, field 15-23, field 15-24, or field 15-25.

Field 15-17 (with 46.75mmboe of gas condensate) is less than 5km from field 15-16 and less than 25km from Alder, Nicol, Brenda, Britannia, Telford, field 15-5, field 15-8, field 15-9, field 15-10, field 15-15, field 15-18, field 15-22, field 15-23, field 15-24, field 15-25, or field 15-26.

Field 15-18 (with 13.36mmboe of oil) is less than 5km from Nicol, less than 10km from Brenda and less than 25km from Lochranza, field 15-11, field 15-16, field 15-17, field 15-23, field 15-24, field 16-12, or field 16-14.

Field 15-19 (with 1.64mmboe of oil) is less than 5km from field 15-21, less than 10km from field 15-20 and less than 25km from Telford, Scott, field 15-12, field 15-13, field 15-14, field 15-15, field 15-22, field 14-11, field 14-12,field 21-1, field 21-2, or field 21-3.

Field 15-20 (with 17mmboe of oil) is less than 10km from Tweedsmuir, Buchan, field 15-19 or field 20-4 and less than 25km from field 14-11, field 20-4, field 21-1, or field 21-2.

Field 15-21 (with 10mmboe of oil) is less than 5km from field 15-19 and less than 25km from Telford, Scott, field 15-12, field 15-13, field 15-14, field 15-15, field 15-16, field 15-20, field 15-22, field 20-4, field 21-1, field 21-2, or field 14-12.

With field 14-12 as a hub the combined reserves of fields 14-11, 15-12, 15-13, 15-14, 15-19, 15-20 and 15-21 give 69.12mmboe. Fields 14-12, 14-11, 15-12, 15-13, 15-14, 15-19 and 15-21 fail both hurdles at all prices. Field 15-20 passes the base hurdle at $70/bbl and 60p/therm giving 17mmboe. On a stand-alone basis the economically producible reserves are 17mmboe which could give RNPV @ 10% of £127.54m at $70/bbl and 60p/therm. The cluster with hub 14-12 fails both hurdles at all prices. But the NPVs@10% are positive for the cluster developments at the $60, 40 pence prices while significantly negative for the stand-alone fields. Field 14-12 is less than 10km from the SAGE pipeline and less than 25km from the Golden Eagle/Claymore pipeline.

Table 28

Results with Stand-Alone and Cluster Developments with Field 14-12 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
14-12	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					68.51	67.05	-382.66	-205.32
$50/bbl 35p/therm high					68.51	67.05	-382.66	-205.32
$60/bbl 40p/therm base					69.20	69.13	-118.89	13.50
$60/bbl 40p/therm high					69.20	69.13	-118.89	13.50
$70/bbl 60p/therm base	17.00		127.54		52.20	69.13	130.20	263.32
$70/bbl 60p/therm high					69.20	69.13	257.74	263.32

Field 15-22 (with 8.04mmboe of oil) is less than 10km from Alder or field 15-23 and less than 25km from Britannia, Callanish, Brodgar, field 15-15, field 15-16, field 15-17, field 15-21, field 15-24, field 15-25, field 21-1, or field 21-2.

Field 15-23 (with 10.81mmboe of oil) is less than 5km from Alder, Britannia, field 15-24 or field 15-25, less than 10km from field 15-22 and less than 25km from Nicol, Brenda, Callanish, Brodgar, field 15-16, field 15-17, field 15-18, or field 15-26.

Field 15-24 (with 6.11mmboe of oil) is less than 5km from Alder, Britannia, field 15-23 or field 15-25, less than 10km from Brenda and less than 25km from Nicol, field 15-16, field 15-17, field 15-18, field 15-22, or field 15-26.

Field 15-25 (with 31.45mmboe of gas and some oil) is less than 5km from Alder, Britannia, field 15-23 or field 15-24, less than 10km from Callanish and less than 25km from Brodgar, Brenda, Enochdhu, field 15-17, field 15-18, field 15-22, or field 15-26.

With field 15-17 as a hub the combined reserves of fields 15-15, 15-16, 15-22, 15-23, 15-24 and 15-25 are 117.55mmboe. Fields 15-17, 15-15, 15-16, 15-22, 15-23, 15-24 and 15-25 fail both hurdles at all prices. The cluster with hub 15-17 only passes the base hurdle at $70/bbl and 60p/therm giving 117.56mmboe and RNPV @ 10% of £490.53m. But the NPV@10% is significantly positive at the $60, 40 pence prices with the cluster development while very negative with stand-alone developments. Field 15-17 is 10km from the SAGE pipeline and 20km from the Scott/Forties pipeline.

Table 29

Results with Stand-Alone and Cluster Developments with Field 15-17 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
15-17	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					112.87	117.56	-659.97	-245.26
$50/bbl 35p/therm high					112.87	117.56	-659.97	-245.26
$60/bbl 40p/therm base					115.25	117.56	-248.55	86.17
$60/bbl 40p/therm high					115.25	117.56	-248.55	86.17
$70/bbl 60p/therm base		117.56		490.53	118.05		360.78	
$70/bbl 60p/therm high					118.05	117.56	360.78	490.53

Field 15-26 (with 13mmboe of gas with a little oil) is less than 5km from Britannia, less than 10km from Alder, Brenda and less than 25km from Nicol, field 15-17, field 15-23. Field 15-24, field 15-25, field 16-12, or field 16-18.

11) Quadrant 16

Quadrant 16 has 20 technical reserves fields. Field 16-1 (with 3mmboe of oil) is less than 10km from field 16-3 and less than 25km from Beinn, East Brae, West Brae, Braemar, Brae, field 16-2, field 16-4, field 16-5, field 16-6 or field 9-24. The Brae fields, however, are planning for decommissioning.

Field 16-2 (with 7.68mmboe of oil) is less than 5km from East Brae, less than 10km from Beinn, field 16-3 or field 16-6 and less than 25km from Braemar, West Brae, Brae, field 16-1, field 16-4, field 16-5, or field 9-24.

Field 16-3 (with 11.55mmboe) of oil is less than 10km from East Brae, Braemar, field 16-1 or field 16-2 and less than 25km from Brae, West Brae, Beinn, field 16-6, field 9-23, or field 9-24.

Field 16-4 (with 10.4mmboe of oil) is less than 10km from West Brae or field 16-5 and less than 25km from Beinn, Brae, field 16-1, or field 16-2.

Field 16-5 (with 3.6mmboe of oil) is less than 5km from West Brae, less than 10km from Brae or field 16-4 and less than 25km from Larch, field 16-1, field 16-2, field 16-6, field 16-7, or field 16-8.

Field 16-6 (with 0.53mmboe of gas) is less than 10km from East Brae, Beinn, or field 16-2 and less than 25km from Brae, Enoch, Braemar, field 16-1, field 16-3, field 16-5, or field 9-24.

With field 16-3 as a hub the combined reserves of fields 16-1, 16-2, 16-4, 16-5, 16-6, 9-23 and 9-24 are 78.86mmboe. Field 16-3 passes the base hurdle at $70/bbl and 60p/therm giving 11.55mmboe as does field 9-24 giving 15mmboe. Fields 16-1, 16-2,16-4, 16-5, 16-6 and 9-23 fail both hurdles at all prices. The cluster with hub 16-3 passes the base hurdle at $70/bbl and 60p/therm giving 78.86mmboe. On a stand-alone basis and the $70/bbl and 60p/therm price the RNPV @ 10% could be £166.01m while the hub RNPV @ 10% could be £467.30m. Field 16-3 is less than 10km from the SAGE pipeline and less than 25km from the Brae/Forties pipeline which is due to decommission. This cluster has less than 5mmboe of gas.

Table 30

Results with Stand-Alone and Cluster Developments with Field 16-3 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
16-3	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					78.86	78.86	-375.49	44.27
$50/bbl 35p/therm high					78.86	78.86	-375.49	44.27
$60/bbl 40p/therm base					78.86	78.86	2.30	267.82
$60/bbl 40p/therm high					78.86	78.86	2.30	267.82
$70/bbl 60p/therm base	26.55	78.86	166.01	467.30	52.33		176.06	
$70/bbl 60p/therm high					78.88	78.86	342.07	467.30

Field 16-7 (with 6.12mmboe of oil with a little gas) is less than 5km from Sycamore, less than 10km from Birch, and less than 25km from Enoch, Larch, field 16-5, field 16-8, field 16-9, or field 16-11.

Field 16-8 (with 5.91mmboe of oil) is less than 10km from Enoch, Larch, Birch, or field 16-9 and less than 25km from Sycamore, field 16-5, or field 16-7.

Field 16-9 (with 8.04mmboe of gas with a little oil) is less than 10km from Enoch or field 16-8 and less than 25km from Birch, Larch, Sycamore, field 16-7, field 16-10, or field 16-11.

Field 16-10 (with 12.64mmboe of oil and gas) is less than 5km from Utguard, less than 10km from Thelma, field 16-11, field 16-16 or field 16-17 and less than 25km from Kinnoull, Burghley, Arundel, field 16-9, field 16-13, field 16-14, or field 16-15. Burghley is tied back to Balmoral FPV.

Field 16-11 (with 11.04mmboe of gas) is less than 10km from field 16-10 and less than 25km from field 16-7, field 16-9, field 16-12, field 16-13, field 16-14, field 16-15, field 16-16, or field 16-17.

With field 16-7 as a hub the combined reserves of fields 16-8, 16-9 and 16-11 are 31.11mmboe. Fields 16-7, 16-8, 16-9 and 16-11 fail both hurdles at all prices. The cluster with hub 16-7 passes the base hurdle at $70/bbl and 60p/therm giving 31.62mmboe and RNPV @10% of £160.49m. Field 16-7 is less than 15km from the SAGE pipeline and less than 5km from the Brae/Forties pipeline which is to be decommissioned.

Table 31

Results with Stand-Alone and Cluster Developments with Field 16-7 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
16-7	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					31.01	31.12	-279.35	-65.19
$50/bbl 35p/therm high					31.01	31.12	-279.35	-65.19
$60/bbl 40p/therm base					31.32	31.62	-173.67	20.73
$60/bbl 40p/therm high					31.32	31.62	-173.67	20.73
$70/bbl 60p/therm base		31.62		160.49	31.55		37.96	
$70/bbl 60p/therm high					31.55	31.62	37.96	160.49

Field 16-12 (which has 10.38mmboe of oil) is less than 10km from field 16-14 and less than 25km from Kinnoul, Burghley, Arundel, Alba, Dumbarton, Thelma, Utguard, field 16-11, field 16-13, field 16-15, field 16-16, field 15-18, or field 15-26.

With field 16-12 as a hub the combined reserves of fields 15-18 and 15-26 are 36.75mmboe. Fields 16-2 and 15-26 fail both hurdles at all prices. Field 15-18 passes the base hurdle at $70/bbl and 60p/therm giving 13mmboe and RNPV @ 10% of £88.32m. The cluster with hub 16-12 fails both hurdles at all prices. But at the $70, 60 pence price case the NPV@10% of the cluster greatly exceeds that of the stand-alone fields. Field 16-12 is less than 25km from the SAGE pipeline and less than 5km from the Brae/Forties pipeline which is to be decommissioned.

Table 32

Results with Stand-Alone and Cluster Developments with Field 16-12 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
16-12	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					36.38	36.75	-187.58	-169.39
$50/bbl 35p/therm high					36.38	36.75	-187.58	-169.39
$60/bbl 40p/therm base					36.75	36.75	-32.31	-38.07
$60/bbl 40p/therm high					36.75	36.75	-32.31	-38.07
$70/bbl 60p/therm base	13.00		88.32		23.75	36.75	76.03	124.63
$70/bbl 60p/therm high					36.75	36.75	164.35	124.63

Field 16-13 (with 2.9mmboe of oil) is less than 5km from Arundel or field 16-15, less than 10km from Kinnoull, Burghley, Farragon or field 16-16 and less than 25km from Cyrus, Beauly, Utguard, Thelma, field 16-10, field 16-11, field 16-12, field 16-14, field 16-17, field 16-18, field 16-19, or field 16-20.

Field 16-14 (with 2.1mmboe of oil) is less than 5km from Burghley, less than 10km from Thelma, field 16-12 or field 16-15 and less than 25km from Arundel, Kinnoull, field 16-10, field 16-13, field 16-16, field 16-17, or field 15-18.

Field 16-15 (with 5.8mmboe of oil) is less than 5km from Burghley or field 16-13, less than 10km from Kinnoull, field 16-14 or field 16-16 and less than 25km

from Thelma, Utguard, Farragon, field 16-10, field 16-11, field 16-12, field 16-17, or field 16-18.

Field 16-16 (with 2.4mmboe of oil with very little gas) is less than 5km from Kinnoull or field 16-17, less than 10km from Arundel, Farragon, field 16-10, field 16-13 or field 16-15 and less than 25km from Utguard, Thelma, Burghley, field 16-11, field 16-12, field 16-14, field 16-18, or field 16-20.

Field 16-17 (with 27.57mmboe of oil) is less than 5km from Kinnoul or field 16-16, less than 10km from Utguard or field 16-10 and less than 25km from Thelma, Burghley, Arundel, Farragon, field 16-11, field 16-13, field 16-14, field 16-15, or field 16-20.

With field 16-17a as a hub the combined reserves of fields 16-10, 16-13, 16-14, 16-15 and 16-16 are 53.41mmboe, and, if 16-20 is added, the reserves increase to 64.52mmboe. Fields 16-17, 16-10, 16-13, 16-14, 16-15, 16-16 and 16-20 fail both hurdles at all prices. The cluster with hub 16-17a passes both hurdles at $70/bbl and 60p/therm giving 53.41mmboe and an RNPV @ 10% of £375.36m. The real NPVs at 10% are also positive under all oil and gas price scenarios with the cluster development while they are significantly negative with stand-alone developments.

Table 33

Results with Stand-Alone and Cluster Developments with Field 16-17a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
16-17a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					53.41	53.41	-285.53	21.87
$50/bbl 35p/therm high					53.41	53.41	-285.53	21.87
$60/bbl 40p/therm base					53.75	53.41	-37.69	199.40
$60/bbl 40p/therm high					53.75	53.41	-37.69	199.40
$70/bbl 60p/therm base		53.41		375.36	53.75		190.46	
$70/bbl 60p/therm high		53.41		375.36	53.75		190.46	

The cluster with hub 16-17b passes the base hurdle at $70/bbl and 60p/therm giving 64.52mmboe and RNPV @10% of £343.59m. Field 16-17 is 10 km from the Langeled pipeline and 25km from the Brae/Forties pipeline which is due to be decommissioned. There is less than 4.5mmboe of gas in this cluster.

Table 34

Results with Stand-Alone and Cluster Developments with Field 16-17b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
16-17b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					64.52	64.52	-338.21	-26.56
$50/bbl 35p/therm high					64.52	64.52	-338.21	-26.56
$60/bbl 40p/therm base					64.87	64.52	-33.39	175.03
$60/bbl 40p/therm high					64.87	64.52	-33.39	175.03
$70/bbl 60p/therm base		64.52		343.59	64.87		243.93	
$70/bbl 60p/therm high					64.87	64.52	243.93	343.59

Field 16-18 (which has 6.51mmboe of oil and gas) is less than 5km from Britannia, less than 10km from Andrew or Cyrus and less than 25km from Farragon, Arundel, Chestnut, Brenda, Burghley, field 16-13, field 16-15, field 16-16, field 16-19, field 16-20 ,or field 15-26.

Field 16-19 (with 3.18mmboe of gas with a little oil) is less than 5km from Maria or field 16-20, less than 10km from Andrew, Cyrus or Farragon and less than 25km from Hawkins, Kinnoull or Utguard, field 16-13, field 16-18, or field 22-1. Maria is tied back to Armada.

Field 16-20 (with 11.12mmboe of oil with very little gas) is less than 5km from Maria or field 16-19, less than 10km from Hawkins, Farragon or Cyrus and less

than 25km from Andrew, field 16-13, field 16-16, field 16-17, field 16-18, or field 22-1.

12) Quadrant 20

Quadrant 20 has 5 technical reserves fields. Field 20-1 (with 2.22mmboe of oil) is less than 5km from Ettrick, less than 10km from field 20-2 or field 20-3, less than 25km from Peregrine, Golden Eagle, Buzzard, field 20-5 or field 14-11 and it is less than 30km from Buchan.

Field 20-2 (with 6.7mmboe of oil) is less than 5km from field 20-3, less than 10km from Ettrick, field 20-1 or field 20-5, and less than 25km from Buchan, Buzzard, field 20-4 or field 14-11.

Field 20-3 (with 25.05mmboe of sour oil and gas) is less than 5km from field 20-2, less than 10km from field 20-1 and less than 25km from Buchan, Ettrick, field 20-4, field 20-5, or field 14-11.

Field 20-4 (with 15mmboe of oil) is less than 10km from field 15-20 and less than 25km from Tweedsmuir, field 20-2, field 20-3, field 14-11, field 21-1, field 21-2, field 21-3, field 15-19, or field 15-21.

Field 20-5 (with 30mmboe of oil) is less than 10km from field 20-2, less than 25km from Ettrick, field 20-1, field 20-3, and less than 30km from Buzzard.

With field 20-3 as a hub the combined reserves of fields 20-1, 20-2, 20-4 and 20-5 give 78.96mmboe. Fields 20-3, 20-1, 20-2 fail both hurdles at all prices. Fields 20-4 and 20-5 pass the base hurdle at $70/bbl and 60p/therm giving 15mmboe and 30mmboe. The cluster with hub 20-3 passes the base hurdle at $70/bbl and 60p/therm giving 78.97mmboe. On a stand-alone basis RNPV @ 10% of £293.44m may be achieved and as a cluster RNPV @ 10% of £418m may be

achieved. Further, real NPV@10% of £202 million is achieved for the cluster with oil price of $60. Field 20-3 is less than 15km from the SAGE pipeline, less than 10km from the Britannia pipeline and less than 35km from the Forties pipeline.

Table 35

Results with Stand-Alone and Cluster Developments with Field 20-3 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
20-3	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					77.71	78.97	-272.68	-26.57
$50/bbl 35p/therm high					77.71	78.97	-272.68	-26.57
$60/bbl 40p/therm base					78.96	78.97	41.91	202.05
$60/bbl 40p/therm high					78.96	78.97	41.91	202.05
$70/bbl 60p/therm base	45.00	78.97	293.44	418.00	33.96		71.51	
$70/bbl 60p/therm high					78.96	78.97	364.95	418.00

13) Quadrant 21

Quadrant 21 has 30 technical reserves fields. Field 21-1 (with 197.86mmboe of oil and gas) is less than 5km from Tweedsmuir, less than 10km from Brodgar, Buchan, field 21-2, or field 21-3, and less than 25km from field 21-4, field 20-4, field 15-19, field 15-20, field 15-21, or field 15-22. The Buchan Area is undergoing re-development. Brodgar is tied back to Britannia.

Field 21-2 (with 4.2mmboe of gas) is less than 5km from Brodgar, less than 10km from field 21-1 and less than 25km from Tweedsmuir, Buchan, field 21-3, field 21-4, field 20-4, field 15-19, field 15-21, or field 15-22.

Field 21-3 (with 7mmboe of oil) is less than 10km from field 21-1 and less than 25km from Buchan, Brodgar, Tweedsmuir, field 21-2, field 21-4, field 20-4, or field 15-20.

With field 21-1 as a hub the combined reserves of fields 21-2 and 21-3 give 209.06mmboe. Field 21-1 passes both hurdles at $70/bbl and 60p/therm giving 198.96mmboe and RNPV @ 10% of £1082.07m. Fields 21-2 and 21-3 fail both hurdles at all prices. The cluster with hub 21-1 passes the base hurdle at $70/bbl and 60p/therm achieving RNPV at 10% of £806.33m. At $70/bbl and 60p/therm the stand-alone fields produce more than the hub, and the RNPV @ 10% is higher with the stand-alone fields. Field 21-1 is less than 5km from the Britannia pipeline, less than 25km from the SAGE pipeline, less than 5km from the Buchan/Forties pipeline and less than 25km from the Forties pipeline.

Table 36

Results with Stand-Alone and Cluster Developments with Field 21-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					209.06	209.10	33.17	-178.98
$50/bbl 35p/therm high					209.06	209.10	33.17	-178.98
$60/bbl 40p/therm base					209.64	209.10	347.45	118.55
$60/bbl 40p/therm high					209.64	209.10	347.45	118.55
$70/bbl 60p/therm base	198.96	209.10	1082.07	806.33	12.12		25.73	
$70/bbl 60p/therm high	198.96		1082.07		12.12	209.10	25.73	806.33

Field 21-4 (with 3mmboe of oil) is less than 5km from Scolty and less than 25km from Forties (which has production till 2047), Brodgar, field 21-1, field 21-2, field 21-3, field 21-5, field 21-6 or field 21-7, and less than 30km from Buchan.

Field 21-5 (which has 12.95mmboe of oil) is less than 5km from field 21-7, less than 10km from Forties or field 21-6 and less than 25km from Brodgar, Enochdhu, Scolty, field 21-4, or field 21-9.

Field 21-6 (with 6.8mmboe of oil with very little gas) is less than 5km from Forties or field 21-7, less than 10km from field 21-5, and less than 25km from field 21-4, or field 21-9.

Field 21-7 (with 13mmboe of oil) is less than 5km from Forties, field 21-5 or field 21-6 and less than 25km from field 21-4, or field 21-9.

Field 21-8 (with 6.01mmboe of oil) is less than 10km from Goosander, field 21-10 or field 21-11 and less than 25km from Grouse, or field 21-12. Goosander is tied back to Kittiwake.

Field 21-9 (with 6mmboe of oil) is less than 5km from Forties and less than 25km from Nelson, Aviat, field 21-5, field 21-6, field 21-7, or field 21-15.

With field 21-7 as a hub the combined reserves of fields 21-4, 21-5, 21-6 and 21-9 are 41.7mmboe. Fields 21-7 and 21-5 pass the base hurdle at $70/bbl and 60p/therm giving 12.96mmboe and 12.95mmboe. Fields 21-4, 21-6 and 21-9 fail both hurdles at all prices. The cluster with hub 21-7 passes the base hurdle at $70/bbl and 60p/therm giving 41.7mmboe. On a stand-alone basis at $70/bbl and 60p/therm RNPV at 10% of £170.97m is achieved, while RNPV @ 10% of £261.18m is achieved by the cluster. With the cluster development an NPV@10% exceeding £143 million is also achieved at the $60, 40 pence prices. Field 21-7 is less than 25km from the Britannia pipeline and less than 10km from the Forties pipeline. There is less than 0.5mmboe of gas in this cluster.

Table 37

Results with Stand-Alone and Cluster Developments with Field 21-7 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-7	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					41.70	39.20	-172.75	-13.34
$50/bbl 35p/therm high					41.70	39.20	-172.75	-13.34
$60/bbl 40p/therm base					41.70	41.70	43.61	143.62
$60/bbl 40p/therm high					41.70	41.70	43.61	143.62
$70/bbl 60p/therm base	25.91	41.70	170.97	261.18	15.80		62.55	
$70/bbl 60p/therm high					41.70	41.70	233.52	261.18

Field 21-10 (with 6.38mmboe of oil) is less than 5km from field 21-11 or field 21-12, less than 10km from Goosander or field 21-8 and less than 25km from Grouse, Gadwall, Mallard or field 21-16. Mallard is tied back to Kittiwake.

Field 21-11 (with 6.73mmboe of oil) is less than 5km from field 21-10 or field 21-12, 10km from Goosander or field 21-8, and less than 25km from Grouse or Gadwall.

Field 21-12 (with 9.19mmboe of oil) is less than 5km from Goosander, field 21-10 or field 21-12 and less than 25km from Grouse, Gadwall or field 21-8.

With field 21-12 as a hub the combined reserves of fields 21-8, 21-10 and 21-11 are 28.31mmboe. Fields 21-12, 21-8, 21-10 and 21-11 fail both hurdles at all prices. The cluster with hub 21-12 passes the base hurdle at $70/bbl and 60p/therm giving 28.31 mmboe and a potential RNPV @ 10% of £152.58m. Further, at the $60 price the cluster yields a RNPV@10% of £70 million. Field 21-12 is less than 25km from the Forties pipeline and there is no gas in this cluster.

Table 38

Results with Stand-Alone and Cluster Developments with Field 21-12 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-12	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					28.31	28.31	-178.55	-44.78
$50/bbl 35p/therm high					28.31	28.31	-178.55	-44.78
$60/bbl 40p/therm base					28.31	28.31	-20.49	70.02
$60/bbl 40p/therm high					28.31	28.31	-20.49	70.02
$70/bbl 60p/therm base		28.31		152.58	28.31		128.76	
$70/bbl 60p/therm high					28.31	28.31	128.76	152.58

Field 21-13 (with 6.2mmboe of HPHT oil) is less than 5km from Cook or field 21-14, less than 10km from Mallard, Teal or field 21-15 and less than 25km from Gadwall, field 21-17, field 21-18, or field 22-7. Cook is tied back to the Anasuria FPSO.

Field 21-14 (with 16.02mmboe of oil and gas) is less than 5km from Mallard, Cook or field 21-13, less than 10km from Gadwall or field 21-15 and less than 25km from Gannet, Teal, field 21-17, field 21-18, or field 22-7.

Field 21-15 (with 2.06 of oil) is less than 10km from field 21-13 or field 21-14 and less than 25km from Grouse, Gadwall, Mallard, Cayley, Arbroath, Godwin, Aviat, field 21-9, field 21-18, field 22-2, or field 22-7.

Field 21-16 (with 10mmboe of oil) is less than 5km from Pict or Saxon, less than 10km from Clapham or field 21-23, and less than 25km from Guillemot, Teal, field 21-10, field 21-17, field 21-18, field 21-20, field 21-21, field 21-22 or field 21-26. Saxon is tied back to the Pict manifold. Guillemot A and Teal are connected to the Anasuria FPSO.

Field 21-17 (with 2.7mmboe of oil) is less than 5km from Teal South or Guillemot, less than 10km from Clapham, field 21-18 or field 21-26 and less than 25km from Cook, Gannet, field 21-13, field 21-14, field 21-16, field 21-21, field 21-22, field 21-23, field 21-24, field 21-25, field 21-27, field 21-28, field 21-29.

Field 21-18 (with 13mmboe of oil) is less than 5km from Teal, less than 10km from Cook, Teal South or field 21-17 and less than 25km from Gannet, Mallard, Gadwall, Pict, field 21-13, field 21-14, field 21-15, field 21-16, field 21-22, field 21-23, or field 21-26.

With field 21-14 as a hub the combined reserves of fields 21-13, 21-15, 21-17 and 21-18 give 39.98mmboe, and, if field 22-7 is added, the reserves increase to 52mmboe. Fields 21-14, 21-13, 21-15, 21-17 fail both hurdles at all prices. Field 21-18 passes the base hurdle at $70/bbl and 60p/therm giving 13mmboe and

RNPV @ 10% of £88.88m. The cluster with hub 21-14 fails both hurdles at all prices. But the real NPV@10% at $70 price exceeds £168 million and at the $60 prices the real NPV@10% exceeds £35 million. Field 21-14 is less than 10km from the Fulmar pipeline and less than 25km from the Forties pipeline.

Table 39

Results with Stand-Alone and Cluster Developments with Field 21-14 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-14	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					39.98	39.98	-206.17	-120.74
$50/bbl 35p/therm high					39.98	39.98	-206.17	-120.74
$60/bbl 40p/therm base					39.98	39.98	-22.06	35.18
$60/bbl 40p/therm high					39.98	39.98	-22.06	35.18
$70/bbl 60p/therm base	13.00		88.88		26.98	39.98	88.46	168.44
$70/bbl 60p/therm high					39.98	39.98	177.34	168.44

Field 21-19 (with 17mmboe of oil) is less than 10km from field 21-20 or field 21-21 and less than 25km from Guillemot, field 21-22, field 21-23, field 21-26, or field 28-1.

Field 21-20 (with 80mmboe of heavy oil) is less than 10km from field 21-19, field 21-21 or field 21-22 and less than 25km from Saxon, Pict, Guillemot, Clapham, field 21-16, field 21-23, field 21-26, or field 28-1.

Field 21-21 (with 13mmboe of oil and a little gas) is less than 5km from field 21-22, less than 10km from field 21-19, field 21-20 or field 21-23 and less than 25km from Guillemot, Saxon, Pict, Clapham, field 21-16, field 21-17, field 21-24, field 21-26 ,or field 28-1.

Field 21-22 (with 5mmboe of oil) is less than 5km from field 21-21, less than 10km from Guillemot West, field 21-20 or field 21-23 and less than 25km from Guillemot, Saxon, Pict, Clapham, field 21-16, field 21-17, field 21-18, field 21-19, field 21-24, field 21-25, field 21-26, field 21-27, field 21-28, field 21-29, or field 28-1. Guillemot West is linked to the Triton FPSO.

Field 21-23 (with 32.66mmboe of oil) is less than 5km from field 21-26, less than 10km from Guillemot West, Clapham, field 21-16, field 21-21 or field 21-22 and less than 25km from Guillemot, Saxon, Pict, field 21-17, field 21-18, field 21-19, field 21-20, field 21-24, field 21-25, field 21-27, field 21-28, field 21-29, or field 28-1.

Field 21-24 (with 1.4mmboe of oil) is less than 5km from field 21-25, less than 10km from field 21-27, field 21-29 or field 28-1 and less than 25km from Guillemot, Gannet, Clapham, field 21-17, field 21-21, field 21-22, field 21-23, field 21-26, field 21-28, or field 29-1.

Field 21-25 (with 5.5mmboe of oil) is less than 5km from field 21-24, field 21-27 or field 21-29, less than 10km from field 21-28 and less than 25km from Gannet, Bittern, field 21-17, field 21-22, field 21-23, field 21-26, field 28-1, or field 29-1. Bittern is a subsea development tied back to the Triton FPSO.

Field 21-26 (with 7mmboe of oil with a little gas) is less than 5km from Guillemot West or field 21-23, less than 10km from Guillemot, Clapham or field 21-17 and

less than 25km from Saxon, Pict, Gannet, field 21-16, field 21-18, field 21-19, field 21-20, field 21-21, field 21-22, field 21-24, field 21-25, field 21-27, field 21-28, field 21-29, or field 28-1.

With field 21-20 as a hub the combined reserves of fields 21-16, 21-19, 21-21, 21-22, 21-23 and 21-26 are164.66mmboe, and, if field 28-1 is added, the reserves increase to 217.98mmboe. Fields 21-20 and 28-1 pass the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and the higher hurdle at $70/bbl and 60p/therm giving 80mmboe and 53.32mmboe. Fields 21-16, 21-21, 21-22 and 21-26 fail both hurdles at all prices. Fields 21-19 and 21-23 pass the base hurdle at $70/bbl and 60p/therm giving 17mmboe and 32.66mmboe. The cluster with hub 21-20a passes the base hurdle at $60/bbl and 40p/therm, and $70/bbl and 60p/therm, and passes the higher hurdle at $70/bbl and 60p/therm giving 164.66mmboe. On a stand-alone basis the fields give 80mmboe or 129.66mmboe achieving RNPV @ 10% of £347.88m at $60/bbl and 40p/therm and £879.88m or £561.54m at $70/bbl and 60p/therm. The cluster could achieve RNPV @ 10% of £755.22m at $60/bbl and 40p/therm, or £1105.78m at $70/bbl and 60p/therm. Even at $50 price the NPV for this cluster exceeds £368 million.

Table 40

Results with Stand-Alone and Cluster Developments with Field 21-20a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-20a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					164.66	164.66	-121.21	368.84
$50/bbl 35p/therm high					164.66	164.66	-121.21	368.84
$60/bbl 40p/therm base	80.00	164.66	347.88	755.22	84.66		109.59	
$60/bbl 40p/therm high					164.66	164.66	457.48	755.22
$70/bbl 60p/therm base	129.66	164.66	879.88	1105.78	35.55		124.39	
$70/bbl 60p/therm high	80.00	164.66	561.54	1105.78	85.21		442.73	

The cluster with hub 21-20b passes the base hurdle at all prices and the higher hurdle at $60/bbl and 40p/therm, and $70/bbl and 60p/therm giving 214.93mmboe. The cluster with hub 21-20b would achieve RNPV @ 10% of £626.82m at $50/bbl and 35p/therm, £1112.78m at $60/bbl and 40p/therm or £1528.38m at $70/bbl and 60p/therm. Field 21-20 is 30km from the Fulmar pipeline and 45km from the Gannet/Fulmar pipeline which is then connected to Norpipe. This cluster has just over 5mmboe of gas.

Table 41

Results with Stand-Alone and Cluster Developments with Field 21-20b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-20b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base		214.93		626.82	217.98		-24.52	
$50/bbl 35p/therm high					217.98	214.93	-24.52	626.82
$60/bbl 40p/therm base	133.32	214.93	622.46	1112.78	84.66		109.59	
$60/bbl 40p/therm high		214.93		1112.78	217.98		732.05	
$70/bbl 60p/therm base	182.98	214.93	1320.86	1528.38	35.55		124.39	
$70/bbl 60p/therm high	133.32	214.93	1002.52	1528.38	85.21		442.73	

Field 21-27 (with 7.97mmboe of oil) is less than 5km from field 21-25, field 21-28 or field 21-29, less than 10km from field 21-24 and less than 25km from Gannet, Guillemot, Bittern, field 21-17, field 21-22, field 21-23, field 21-26, field 28-1, or field 29-1.

Field 21-28 (with 2mmboe of oil with very little gas) is less than 5km from Gannet F, field 21-27 or field 21-29, less than 10km from field 21-25 and less than 25km from Guillemot, Bittern, field 21-17, field 21-22, field 21-23, field 21-24, field 21-26, field 22-18, field 28-1, or field 29-1. Gannet F is tied back to Gannet A.

Field 21-29 (with 14.76mmboe of oil with very little gas) is less than 5km from field 21-25, field 21-27 or field 21-28, less than 10km from Gannet F or field 21-24 and less than 25km from Gannet, Guillemot, Bittern, field 21-17, field 21-22, field 21-23, field 21-26, field 22-18, field 28-1, or field 29-1.

The exact co-ordinates of field 21-30 (which has 60.17mmboe of oil and gas) and passes the base hurdle at $70/bbl and 60p/therm are unknown.

With field 21-29 as a hub the combined reserves of fields 21-24, 21-25, 21-27 and 21-28 are 31.63mmboe. If field 22-18 is added the reserves increase to 36.63mmboe. If fields 28-1 and 29-1 are added the reserves increase to 94.96mmboe. Field 21-29 passes the base hurdle at $70/bbl and 60p/therm giving 14.76mmboe. Fields 21-24, 21-25, 21-27, 21-28, 22-18 and 29-1 fail both hurdles at all prices. Field 28-1 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and passed the higher hurdle at $70/bbl and 60p/therm giving 53.32mmboe. Clusters with hubs 21-29a, 21-29b and 21-29c pass the base hurdle at $70/bbl and 60p/therm giving reserves of 31.64mmboe, 36.64mmboe and 94.96mmboe respectively. On a stand-alone basis the 21-29a fields individually could attain RNPV @ 10% of £95.26m whilst the cluster could attain £164.18m. On a stand-alone basis the 21-29b fields could attain RNPV @ 10% of £95.26m whilst the cluster could attain £198.32m. On a stand-alone basis the 21-29c fields could attain RNPV @ 10% of £274.57m at $60/bbl and 40p/therm, and £536.24m or £440.98m at $70/bbl and 60p/therm, whilst the cluster could attain £392.54m at $60/bbl and 40p/therm and £616.12m at $70/bbl and 60p/therm. Even with the $50, 35 pence price case the real NPV for the cluster exceeds £115 million. Field 21-29 is less than 10km from the Fulmar pipeline and less than 10km from the Gannet/Fulmar pipeline. This cluster has less than 2mmboe of gas.

Table 42

Results with Stand-Alone and Cluster Developments with Field 21-29a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-29a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					31.63	31.64	-160.37	-55.95
$50/bbl 35p/therm high					31.63	31.64	-160.37	-55.95
$60/bbl 40p/therm base					31.63	31.64	-1.08	68.76
$60/bbl 40p/therm high					31.63	31.64	-1.08	68.76
$70/bbl 60p/therm base	14.76	31.64	95.26	164.18	16.87		48.63	
$70/bbl 60p/therm high					31.63	31.64	143.89	164.18

Table 43
Results with Stand-Alone and Cluster Developments with Field 21-29b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-29b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					36.63	36.64	-200.33	-53.45
$50/bbl 35p/therm high					36.63	36.64	-200.33	-53.45
$60/bbl 40p/therm base					36.63	36.64	-12.64	88.79
$60/bbl 40p/therm high					36.63	36.64	-12.64	88.79
$70/bbl 60p/therm base	14.76	36.64	95.26	198.32	21.87		65.40	
$70/bbl 60p/therm high					36.63	36.64	160.66	198.32

Table 44
Results with Stand-Alone and Cluster Developments with Field 21-29c as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
21-29c	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					94.96	94.96	-142.10	115.44
$50/bbl 35p/therm high					94.96	94.96	-142.10	115.44
$60/bbl 40p/therm base	53.32	94.96	274.57	392.54	41.63		-22.33	
$60/bbl 40p/therm high					94.96	94.96	252.25	392.54
$70/bbl 60p/therm base	68.08	94.96	536.24	616.12	26.87		84.25	
$70/bbl 60p/therm high	53.32	94.96	440.98	616.12	41.63		179.51	

14) Quadrant 22

Quadrant 22 has 22 technical reserves fields. Field 22-1 (with 5.7mmboe of oil) is less than 25km from Hawkins, Seymour, Andrew, Chestnut, Aviat, Everest, field 16-19, or field 16-20.

With field 16-20 as a hub the combined reserves of fields 16-18, 16-19 and 22-1 are 26.51mmboe. Fields 16-20, 16-18, 16-19 and 22-1 fail both hurdles at all prices. The cluster with hub 16-20 fails both hurdles at all prices. Field 16-20 is less than 5km from the Langeled pipeline, less than 30km from the CATS pipeline, and less than 35km from the Brae/Forties pipeline which is to be decommissioned. There is less than 8mmboe of gas in this cluster.

Table 45

Results with Stand-Alone and Cluster Developments with Field 16-20 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
16-20	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					26.51	26.51	-179.44	-135.31
$50/bbl 35p/therm high					26.51	26.51	-179.44	-135.31
$60/bbl 40p/therm base					26.90	26.51	-59.81	-37.44
$60/bbl 40p/therm high					26.90	26.51	-59.81	-37.44
$70/bbl 60p/therm base					26.90	26.51	98.70	82.18
$70/bbl 60p/therm high					26.90	26.51	98.70	82.18

Field 22-2 (with 9.79mmboe of oil and gas) is less than 10km from Nelson, Howe, Montrose, or field 22-7, and 25km from Godwin, Arbroath, Andrew, Aviat, field 22-3, field 22-8 or field 21-15.

Field 22-3 (with 5mmboe of oil) is less than 10km from Howe and 25km from Everest, Montrose, Godwin, Arbroath, field 22-2, field 22-4, field 22-6, or field 22-8.

Field 22-4 (with 10mmboe of oil) is less than 25km from Everest, Montrose, Howe, field 22-3, field 22-5, field 22-6, field 22-8, field 22-9, or field 22-10.

Field 22-5 (with 9.28mmboe of oil and gas) is less than 10km from field 22-6 and 25km from Everest, Mungo, field 22-4, or field 22-10.

Field 22-6 (with 1.7mmboe of oil) is less than 5 km from Everest, less than 10km from field 22-5, and 25km from Monan, Mungo, field 22-3, or field 22-4.

Field 22-7 (with 11.94mmboe of oil with some gas) is less than 5km from Montrose, less than 10km from Godwin or field 22-2, and 25km from Arbroath, Nelson, Howe, field 22-8, field 21-13, field 21-14, or field 21-15.

With field 22-2 as a hub the combined reserves of fields 22-3 and 22-7 are 26.74mmboe. Fields 22-2, 22-3 and 22-7 fail both hurdles at all prices. The cluster with hub 22-2 fails both hurdles at all prices. Field 22-2 is less than 5km from the Langeled pipeline, and less than 5km from the Montrose/Forties pipeline.

Table 46

Results with Stand-Alone and Cluster Developments with Field 22-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
22-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					26.74	26.74	-195.90	-160.05
$50/bbl 35p/therm high					26.74	26.74	-195.90	-160.05
$60/bbl 40p/therm base					27.01	26.74	-85.80	-67.16
$60/bbl 40p/therm high					27.01	26.74	-85.80	-67.16
$70/bbl 60p/therm base					27.01	26.74	79.97	64.32
$70/bbl 60p/therm high					27.01	26.74	79.97	64.32

Field 22-8 (with 24mmboe of oil) is less than 10km from Montrose or Wood, and 25km from Arbroath, Brechin, Arkwright, Marnoch, field 22-2, field 22-3, field 22-4, field 22-7, field 22-9, field 22-10 or field 22-16. Wood is part of the Montrose redevelopment, and Brechin is tied back to Arkwright.

Field 22-9 (with 17.92mmboe of gas condensate) is less than 5km from Brechin, less than 10km from Arkwright, Marnoch, field 22-10 or field 22-16 and 25km from Monan, Mirren, field 22-4, field 22-8, field 22-13, field 22-14, field 22-15, field 22-20, or field 22-21. Mirren is part of ETAP.

Field 22-10 (which has 19.51mmboe of gas condensate) is less than 10km from field 22-9 and less than 25km from Mungo, Monan, Mirren, Marnoch, Arkwright, Brechin, Shaw, Carnoustie, Wood, Arbroath, Godwin, Montrose, field 22-4, field 22-5, field 22-8, field 22-14, or field 22-16.

With field 22-4 as a hub the combined reserves of fields 22-5, 22-6, 22-8 and 22-10 are 64.49mmboe. Fields 22-4, 22-5, 22-6 and 22-10 fail both hurdles at all prices. Field 22-8 passes the base hurdle at $70/bbl and 60p/therm giving 24mmboe and RNPV @ 10% of £127.70m. The cluster with hub 22-4 passes the base hurdle at $70/bbl and 60p/therm, giving 64.49mmboe and RNPV @ 10% of £258.75m. At the $60 and 40 pence price scenario the NPV of the cluster exceeds £77 million. Field 22-4 is less than 10km from the CATS pipeline and 25km from the Montrose/Forties pipeline.

Table 47

Results with Stand-Alone and Cluster Developments with Field 22-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
22-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					64.41	64.49	-296.32	-129.93
$50/bbl 35p/therm high					64.41	64.49	-296.32	-129.93
$60/bbl 40p/therm base					64.67	64.49	-36.34	77.23
$60/bbl 40p/therm high					64.67	64.49	-36.34	77.23
$70/bbl 60p/therm base	24.00	64.49	127.70	258.75	40.67		114.60	
$70/bbl 60p/therm high					64.67	64.49	242.30	258.75

Field 22-11 (with 3.4mmboe of gas) is less than 5km from Madoes or field 22-12, less than 10km from Shaw, field 22-13 or field 22-14, and 25km from Gannet, Marnoch, Arkwright, Brechin, Carnoustie, field 22-15, field 22-17, field 22-18, field 22-19, field 22-20, or field 29-3. Madoes is tied back to ETAP and Shaw is part of the Montrose Area redevelopment.

Field 22-12 (with 12.28mmboe of oil with some gas) is less than 5km from field 22-11, less than 10km from Shaw and 25km from Madoes, Marnoch, Gannet, Carnoustie, Arkwright, field 22-13, field 22-14, field 22-15, field 22-17, field 22-18, field 22-19 or field 22-20.

Field 22-13 (with 15.75mmboe of gas condensate) is less than 5km from Madoes or field 22-15, less than 10km from Marnoch, field 22-11, field 22-14 or field 22-20, and 25km from Shaw, Arkwright, Brechin, Heron, field 22-9, field 22-12, field 22-16, field 22-17, field 22-18, field 22-19, field 22-21, or field 29-3. Heron is part of ETAP.

Field 22-14 (with 7.16mmboe of oil with a little gas) is less than 10km from Shaw, Marnoch, Madoes, Arkwright, field 22-11, field 22-13 or field 22-15 and 25km from Gannet, Carnoustie, Heron, field 22-9, field 22-12, field 22-16, field 22-17, field 22-18, field 22-19, or field 22-20.

Field 22-15 (with 2.8mmboe of gas with a little oil) is less than 5km from Marnoch, field 22-13 or field 22-20, less than 10km from Madoes, field 22-11 or field 22-14 and 25km from Arkwright, Brechin, Shaw, Heron, field 22-9, field 22-12, field 22-16, field 22-17, field 22-18 field 22-19, field 22-21, field 22-22, or field 29-3.

Field 22-16 (with 2.76mmboe of gas condensate) is less than 10km from Mirren, Monan, or field 22-9 and 25km from Arkwright, Brechin, Shaw, Wood, Carnoustie, Heron, field 22-8, field 22-10, field 22-13, field 22-14, field 22-15, field 22-20, field 22-21, field 22-22, or field 23-1.

Field 22-17 (with 11.04mmboe of gas condensate) is less than 10km from Starling, field 22-19 or field 29-3, and 25km from Madoes, Kyle, Bittern, field 22-11, field 22-12, field 22-13, field 22-14, field 22-15, field 22-18, field 22-20, field 29-1, field 29-2 or field 29-11. Kyle production is processed on the Curlew FPSO. Starling production is via the Shearwater complex.

Field 22-18 (with 5mmboe of oil) is less than 25km from Gannet, Madoes, Starling, Shaw, field 22-11, field 22-12, field 22-13, field 22-14, field 22-15, field 22-17, field 22-19, field 21-28, field 21-29, field 29-1, or field 29-3.

Field 22-19 (with 5.73mmboe of gas condensate) is less than 10km from Starling, field 22-17 or field 29-3 and 25km from Shearwater, Elgin, Glenelg, Kyle, Madoes, Heron, field 22-11, field 22-12, field 22-13, field 22-14, field 22-15, field 22-18, field 22-20, field 29-1, field 29-2, field 29-10, or field 29-11. Shearwater is a HPHT field.

Field 22-20 (with 19.83mmboe of oil with a little gas) is less than 5km from field 22-15, less than 10km from Heron, Madoes, Marnoch or field 22-13 and 25km from Shearwater, Elgin, Glenelg, Scoter, Shaw, Arkwright, Brechin, field 22-9, field 22-11, field 22-12, field 22-14, field 22-16, field 22-17, field 22-19, field 22-21, field 22-22, or field 29-3. Merganser and Scoter are part of ETAP.

With field 22-20 as a hub the combined reserves of fields 22-9, 22-11, 22-12, 22-13, 22-14, 22-15, 22-16, 22-17 and 22-9 give a total of 98.67mmboe. Fields 22-20, 22-9 and 22-13 pass the base hurdle at $70/bbl and 60p/therm giving 19.36mmboe, 18.35mmboe, 15.75mmboe and total RNPV @10% of £300.30m. Fields 22-11, 22-12, 22-14, 22-15, 22-16, 22-17 and 22-19 fail both hurdles at all prices. The cluster with hub 22-20 passes the base hurdle at $70/bbl and 60p/therm, giving 98.68mmboe and attaining RNPV @ 10% of £382.73m. The cluster NPV at $60 and 40 pence price scenario is also positive. Field 22-20 is 20km from the CATS pipeline, less than 5km from the Shearwater/Marnock pipeline which links to the Forties pipeline, and 30km from Norpipe.

Table 48

Results with Stand-Alone and Cluster Developments with Field 22-20 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
22-20	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					98.44	93.75	-496.12	-262.85
$50/bbl 35p/therm high					98.44	93.75	-496.12	-262.85
$60/bbl 40p/therm base					99.53	98.68	-129.23	20.90
$60/bbl 40p/therm high					99.53	98.68	-129.23	20.90
$70/bbl 60p/therm base	53.46	98.68	300.30	382.73	46.07		118.03	
$70/bbl 60p/therm high					99.53	98.68	418.33	382.73

Field 22-21 (with 19.27mmboe of gas condensate) is less than 5km from Merganser, Heron or field 22-22, less than 10km from Scoter and 25km from Mirren, Machar, Shearwater, Elgin, Glenelg, Marnoch, Pierce, field 22-9, field 22-13, field 22-15, field 22-16, field 22-20, field 23-1, field 23-2, or field 30-3.

Field 22-22 (with 12.39mmboe of gas condensate) is less than 5km from Scoter, Merganser or field 22-21, less than 10km from Heron or field Machar, and 25km from Pierce, Erskine, Shearwater, Elgin, Glenelg, Mirren, field 22-15, field 22-16, field 22-20, field 23-1, field 23-2, field 30-1, field 30-2, field 30-3, field 30-4, field 30-6, or field 30-7.

15) Quadrant 23

Quadrant 23 has 2 technical reserves fields. Field 23-1 (with 19.46mmboe of gas condensate) is less than 5km from field 23-2, less than 10km from Pierce and 25km from Mirren, Merganser, Scoter, Monan, Mungo, Macher, field 22-16, field 22-21, or field 22-22. An FPSO is used for Pierce.

Field 23-2 (with 36.01mmboe of gas condensate) is less than 5km from Pierce or field 23-1, and 25km from Mirren, Merganser, Scoter, Monan, Mungo, Macher, field 22-21, or field 22-22.

With field 23-2 as a hub the combined reserves of fields 22-21, 22-22 and 23-1 are 87.13mmboe. Fields 23-2, 22-21, 22-22 fail both hurdles at all prices. Field 23-1 passes the base hurdle at $70/bbl and 60p/therm giving 19.92mmboe and RNPV @ 10% of £95.93m. The cluster with hub 23-2 passes the base hurdle at $70/bbl and 60p/therm, giving 87.14mmboe and attaining RNPV @ 10% of £332.60m. Field 23-2 is less than 15km from the Lomond/Everest link that gives access to CATS, less than 5km from the Erskine/Lomond condensate pipeline ,and less than 20km from the Marnock/Machar pipeline which links with the Forties pipeline.

Table 49

Results with Stand-Alone and Cluster Developments with Field 23-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
23-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					87.13	87.14	-428.81	-220.27
$50/bbl 35p/therm high					87.13	87.14	-428.81	-220.27
$60/bbl 40p/therm base					87.94	87.14	-198.71	-37.65
$60/bbl 40p/therm high					87.94	87.14	-198.71	-37.65
$70/bbl 60p/therm base	19.92	87.14	95.93	332.60	68.59		215.13	
$70/bbl 60p/therm high					88.52	87.14	311.06	332.60

16) Quadrant 28

Quadrant 28 has 3 technical reserves fields. Field 28-1 (with 53.32mmboe of oil) is less than 25km from Guillemot, Varado, Burgman, Catcher, field 28-2, field 21-19, field 21-20, field 21-21, field 21-22, field 21-23, field 21-24, field 21-25, field 21-26, field 21-27, field 21-28, or field 21-29. Burgman, in the Catcher area, is produced using an FPSO.

Field 28-2 (with 1mmboe of oil) is less than 5km from Burgman, less than 10km from Catcher, Varado or field 28-3 and less than 25 km from field 28-1.

Field 28-3 (with 7mmboe of oil) is less than 5km from Burgman, less than 10km from Catcher, Varado, or field 28-2.

With field 28-2 as a hub the combined reserves of fields 28-1 and 28-3 give a total of 61.32mmboe. Fields 28-2 and 28-3 fail both hurdles at all prices. Field 28-1 passes the base hurdle at $60/bbl and 40p/therm, and $70/bbl and 60p/therm, and passes the higher hurdle at $70/bbl and 60p/therm giving 53.32mmboe and achieving RNPV @ 10% of £274.57m at $60/bbl and 40p/therm and £440.98m at $70/bbl and 60p/therm. The cluster with hub 28-2 passes the base hurdle at $70/bbl and 60p/therm, giving 61.32mmboe and achieving RNPV @ 10% of £357.59m. But the returns for the stand-alone development are generally higher than those for the cluster. Field 28-2 is not near any oil pipelines and the cluster is oil only.

Table 50

Results with Stand-Alone and Cluster Developments with Field 28-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
28-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					61.32	61.32	43.93	16.55
$50/bbl 35p/therm high					61.32	61.32	43.93	16.55
$60/bbl 40p/therm base	53.32		274.57		8.00	61.32	-7.25	206.13
$60/bbl 40p/therm high					61.32	61.32	267.33	206.13
$70/bbl 60p/therm base	53.32	61.32	440.98	357.59	8.00		36.04	
$70/bbl 60p/therm high	53.32		440.98		8.00	61.32	36.04	357.59

17) Quadrant 29

Quadrant 29 has 16 technical reserves fields. Field 29-1 (with 5mmboe of oil) is less than 10km from Bittern and less than 25km from Kyle, Starling, field 29-2, field 29-3, field 29-7, field 29-8, field 21-24, field 21-25, field 21-27, field 21-28, field 21-29, field 22-17, field 22-18, or field 22-19.

Field 29-2 (with 54.47mmboe of gas) is less than 5km from Kyle, less than 10km from Fram, field 29-8 or field 29-10 and less than 25km from Curlew, Starling, field 29-1, field 29-3, field 29-7, field 29-9, field 29-11, field 29-12, field 22-17, or field 22-19. Production from Fram goes to Stirling.

Field 29-3 (with 10mmboe of oil) is less than 5km from Starling, less than 10km from field 22-17 or field 22-19 and less than 25km from Kyle, Fram, Franklin, Glenelg, Madoes, Shearwater, field 29-1, field 29-2, field 29-6, field 29-8, field 29-9, field 29-10, field 29-11, field 29-12, field 22-11, field 22-13, field 22-15, field 22-18, or field 22-20. Franklin is an HPHT development.

The exact co-ordinates of field 29-4 (which has 22.96mmboe of gas condensate) and field 29-5 (which has 30.05mmboe of oil) are unknown. Field 29-4 fails both hurdles at all prices.

Field 29-5 passes the base hurdle at $70/bbl and 60p/therm giving 30.05mmboe.

Field 29-6 (HPHT field with 18.33mmboe of gas condensate) is less than 5km from field 29-12, less than 10km from Fram, Franklin or field 29-14 and less than 25km from Glenelg, Shearwater, Stella, Starling, field 29-3, field 29-9, field 29-10, field 29-11, field 29-13, field 29-15, field 30-1, or field 30-3.

Field 29-7 (with 9.99mmboe of oil) is less than 10km from Kyle, Bittern, field 29-2, field 29-8, and less than 25km from Curlew, Catcher, Varadero, Burghman, Fram, Starling, field 29-1, field 29-2 or field 29-10.

Field 29-8 (with 1.39mmboe of oil with very little gas) is less than 10km from Curlew, Kyle, Fram, field 29-2, field 29-7 or field 29-10, and less than 25km from Starling, field 29-1, field 29-3, field 29-9, or field 29-11.

Field 29-9 (with 16.3mmboe of oil and gas) is less than 10km from Curlew, Fram, field 29-10, field 29-11 or field 29-13, and less than 25km from Kyle, Starling, field 29-2, field 29-3, field 29-6, field 29-8, field 29-12, field 29-14, or field 29-15.

Field 29-10 (with 3.34mmboe of oil with very little gas) is less than 5 km from Fram or field 29-11, less than 10km from Curlew, field 29-2, field 29-8, or field 29-9 and less than 25km from Kyle, Starling, field 29-3, field 29-6, field 29-7, field 29-12, field 29-13, or field 22-19.

Field 29-11 (with 2.8mmboe of oil with very little gas) is less than 5km from Fram, field 29-10 or field 29-12, less than 10km from field 29-9 and less than 25km from Starling, Franklin, Curlew, Kyle, field 29-2, field 29-3, field 29-6, field 29-8, field 29-13, field 29-14, field 29-15, field 22-17, or field 22-19.

With field 29-2 as a hub the combined reserves of fields 29-3, 29-7, 29-8, 29-9, 29-10 and 29-11 are 98.29mmboe. Fields 29-2, 29-3, 29-7, 29-8, 29-10 and 29-11 fail both hurdles at all prices. Field 29-9 passes the base hurdle at $70/bbl and 60p/therm giving 16.89mmboe and achieving RNPV @ 10% of £92.43m. The cluster with hub 29-2 passes the base hurdle at $70/bbl and 60p/therm giving 99.21mmboe and attaining RNPV @10% of £529.54m. With the $60, 40 pence scenario the cluster development produces a real NPV@10% of £177 million

compared to -£196 million with stand-alone developments. Field 29-2 is less than 5km from the CATS pipeline, and less than 5km from the Gannet/Fulmar pipeline which is then connected to Norpipe.

Table 51

Results with Stand-Alone and Cluster Developments with Field 29-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%		
29-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail	
$50/bbl 35p/therm base					98.29	98.30	-499.99	-44.29	
$50/bbl 35p/therm high					98.29	98.30	-499.99	-44.29	
$60/bbl 40p/therm base					98.29	99.21	-195.64	176.76	
$60/bbl 40p/therm high					98.29	99.21	-195.64	176.76	
$70/bbl 60p/therm base	16.89	99.21	92.43	529.54	81.99		256.81		98.87
$70/bbl 60p/therm high					98.87	99.21	349.24	529.54	

Field 29-12 (HPHT field with 11.63mmboe of gas condensate) is less than 5km from field 29-6 or field 29-11, less than 10km from field 29-13 or field 29-14, and less than 25km from Stella, Franklin, Curlew, Starling, field 29-2, field 29-3, field 29-9, field 29-10, field 29-15, field 30-1 or field 30-3.

Field 29-13 (with 24.49mmboe of oil with a little gas) is less than 10km from Fram, field 29-9, or field 29-12, and less than 25km from Curlew, Franklin, Stella, field 29-6, field 29-10, field 29-11, field 29-14, field 29-15, or field 30-14.

Field 29-14 (with 25.47mmboe of oil) is less than 10km from Stella, field 29-6, field 29-12 or field 29-15 and less than 25km from Shearwater, Franklin, Fram, field 29-9, field 29-11, field 29-13, field 30-1, field 30-2, field 30-3, field 30-5, field 30-8, field 30-9, or field 30-14.

Field 29-15 (with 6.46mmboe of gas condensate) is less than 10km from Stella or field 29-14 and less than 25km from Fram, Franklin, field 29-6, field 29-9, field 29-11, field 29-12, field 29-13, field 30-1, field 30-8, field 30-9, field 30-12, field 30-13, or field 30-14.

With field 29-14 as a hub the combined reserves of fields 29-6, 29-12, 29-13 and 29-15 are 86.37mmboe. Fields 29-14, 29-6 and 29-13 pass the base hurdle at $70/bbl and 60p/therm giving 25.47mmboe, 18.77mmboe and 24.49mmboe respectively. Fields 29-12 and 29-15 fail both hurdles at all prices. The cluster with hub 29-14 passes the base hurdle at $70/bbl and 60p/therm. On a stand-alone basis the fields could achieve RNPV @ 10% of £357.65m, and the hub could achieve £393.66m. It is noteworthy that at the $60, 40 pence price case the NPV@10% of the cluster development exceeds £101 million, while with stand-alone development the NPV is -£3 million. Field 29-14 is less than 5km from the SEAL pipeline and less than 20km from the Gannet/Fulmar pipeline which is then connected to Norpipe.

Table 52

Results with Stand-Alone and Cluster Developments with Field 29-14 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
29-14	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					86.37	82.08	-320.62	-156.67
$50/bbl 35p/therm high					86.37	82.08	-320.62	-156.67
$60/bbl 40p/therm base					87.13	86.40	-2.98	101.12
$60/bbl 40p/therm high					87.13	86.40	-2.98	101.12
$70/bbl 60p/therm base	68.72	86.40	357.65	393.66	18.41		21.71	
$70/bbl 60p/therm high					87.13	86.40	379.36	393.66

Field 29-16 (with 30.95mmboe of gas) is less than 5km from Auk and less than 25km from Fulmar, Clyde, field 30-12, field 30-13, field 30-14, field 30-15, or field 30-16.

18) Quadrant 30

Quadrant 30 has 23 technical reserves fields. Field 30-1 (with 135.89mmboe of gas condensate) is less than 10km from Stella, Franklin, field 30-2, field 30-3, field 30-4, field 5 or field 30-7 and less than 25km from Blane, Jasmine, Harrier, Judy, Machar, Shearwater, Elgin, field 30-6, field 30-8, field 30-9, field 30-10, field 29-6, field 29-12, field 29-14, field 29-15 or field 22-22. Blane is tied back to a platform in Norwegian waters. Field 30-1 is 10km from the SEAL pipeline

and 25km from the Marnock/ Machar pipeline which links with the Forties pipeline.

Field 30-2 (with 102.61mmboe of gas condensate) is less than 5km from field 30-4, field 30-5, field 30-6 or field 30-7, less than 10km from field 30-1 or field 30-3 and less than 25km from Blane, Machar, Shearwater, Elgin, Glenelg, Franklin, Stella, Jasmine, Harrier, Judy, field 30-8, field 30-9, field 30-10, field 29-14 or field 22-22.

Field 30-3 (with 30.8mmboe of gas condensate) is less than 5km from Franklin, less than 10km from Elgin, Shearwater, field 30-1, field 30-2, field 30-4 or field 30-7 and less than 25km from Blane, Stella, Machar, Harrier, Jasmine, Glenelg, field 30-5, field 30-6, field 30-8, field 30-9, field 29-6, field 29-12, field 29-14, field 22-21, or field 22-22.

Field 30-4 (with 36.06mmboe of gas condensate) is less than 5km from field 30-2, field 30-6 or field 30-7, less than 10km from field 30-1, field 30-3 or field 30-5 and less than 25km from Blane, Franklin, Elgin, Shearwater, Machar, Glenelg, Stella, Harrier, Jasmine, Judy, field 30-8, field 30-9, field 30-10 or field 22-22.

Field 30-5 (with 10.96mmboe of oil) is less than 5km from field 30-2, field 30-6 or field 30-7, less than 10km from field 30-1 or field 30-4, and less than 25km from Blane, Stella, Jasmine, Harrier, Judy, Franklin, Shearwater, Machar, Elgin, field 30-3, field 30-8, field 30-9, field 30-10, or field 29-14.

Field 30-6 (with 1.73mmboe of oil) is less than 5km from field 30-2, field 30-4, field 30-5, or field 30-7, and less than 25km from Franklin, Elgin, Glenelg, Shearwater, Machar, Blane, Stella, Jasmine, Harrier, Judy, field 30-1, field 30-3, field 30-8, field 30-9, field 30-10, or field 22-22.

Field 30-7 (with 5.58mmboe of gas condensate) is less than 5km from field 30-2, field 30-4, field 30-5 or field 30-6, less than 10km from field 30-1 or field 30-3, and less than 25km from Franklin, Elgin, Glenelg, Shearwater, Machar, Blane, Stella, Jasmine, Harrier, Judy, field 30-2, field 30-8, field 30-9 or field 30-10.

Field 30-8 (with 3.53mmboe of gas condensate) is less than 5km from Jasmine, Harrier, Judy or field 30-9, less than 10km from Stella and less than 25km from Joanne, Blane, Franklin, field 30-1, field 30-2, field 30-3, field 30-4, field 30-5, field 30-6, field 30-7, field 30-10, field 30-11, field 30-12, field 30-13, field 30-14, field 30-15, field 30-18, field 30-19, field 29-14, or field 29-15.

Field 30-9 (with 7.11mmboe of gas condensate) is less than 5km from Judy or field 30-8, less than 10km from Jasmine, Joanne, Harrier or field 30-10 and less than 25km from Blane, Stella, Franklin, field 30-1, field 30-2, field 30-3, field 30-4, field 30-5, field 30-6, field 30-7, field 30-11, field 30-12, field 30-13, field 30-14, field 30-15, field 30-17, field 30-18, field 30-19, field 29-14 or field 29-15.

Field 30-10 (with 46.8mmboe of oil) is less than 10km from Blane or field 30-9 and less than 25km from Stella, Jasmine, Harrier, Judy, Joanne, field 30-1, field 30-4, field 30-5, field 30-6, field 30-7, field 30-8, field 30-11, field 30-17, field 30-18, or field 30-19.

With field 30-2 as a hub the combined reserves of fields 30-3, 30-4, 30-5, 30-6, 30-7, 30-8, 30-9 and 30-10 are 245.18mmboe, and, if field 30-1 is included, the reserves increase to 381.07mmboe. Fields 30-2 and 30-1 pass both hurdles at $70/bbl and 60p/therm giving 103.72mmboe, and fields 30-4 and 30-8 pass the base hurdle at $70/bbl and 60p/therm giving a total of 190.46mmboe. Fields 30-3, 30-5, 30-6, 30-7 and 30-9 fail both hurdles at all prices. Fields 30-4, 30-8 and 30-10 pass the base hurdle at $70/bbl and 60p/therm giving 36.64mmboe,

3.85mmboe and 46.24mmboe. The cluster with hub 30-2a passes the base hurdle at $60/bbl and 40p/therm, and $70/bbl and 60p/therm giving 241.77mmboe. It passes both hurdles at $70/bbl and 60p/therm giving 245.21mmboe. On a stand-alone basis the fields could achieve RNPV @ 10% of £1133.86m or £626.28m at $70/bbl and 60p/therm, whilst the cluster could achieve RNPV @ 10% of £693.43m at $60/bbl and 40p/therm, and £1297.69m at $70/bbl and 60p/therm.

Table 53

Results with Stand-Alone and Cluster Developments with Field 30-2a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
30-2a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					240.69	241.77	-342.42	302.95
$50/bbl 35p/therm high					240.69	241.77	-342.42	302.95
$60/bbl 40p/therm base		241.77		693.43	247.14		329.25	
$60/bbl 40p/therm high					247.14	241.77	329.25	693.43
$70/bbl 60p/therm base	190.46	245.21	1133.86	1297.69	56.68		155.02	
$70/bbl 60p/therm high	103.72	245.21	626.28	1297.69	143.42		662.59	

The cluster with hub 30-2b passes the hurdles at all prices giving 381.12mmboe. Field 30-1 passes both hurdles at $70/bbl and 60p/therm. On a stand-alone basis the fields give 327.98mmboe or 241.24mmboe, and achieve RNPV @ 10% of £1936.05m and £1428.47m at $70/bbl and 60p/therm. The cluster achieves RNPV @ 10% of £1199.75m at $50/bbl and 35p/therm, £1701.57m at $60/bbl

and 40p/therm or £2681.03m at $70/bbl and 60p/therm. Field 30-2 is less than 10km from the SEAL pipeline and less than 20km from the Marnock/Machar pipeline which links with the Forties pipeline.

Table 54

Results with Stand-Alone and Cluster Development with Field 30-2b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
30-2b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base		381.12		1199.75	378.22		-210.19	
$50/bbl 35p/therm high		381.12		1199.75	378.22		-210.19	
$60/bbl 40p/therm base		381.12		1701.57	384.66		721.11	
$60/bbl 40p/therm high		381.12		1701.57	384.66	381.12	721.11	1701.57
$70/bbl 60p/therm base	327.98	381.12	1936.05	2681.03	56.68		155.02	
$70/bbl 60p/therm high	241.24	381.12	1428.47	2681.03	143.42		662.59	

Field 30-11 (HPHT field with 14.59mmboe of oil and gas) is less than 10km from Joanne or Judy and less than 25km from Blane, Harrier, Jasmine, Stella, Flyndre, Cawdor, field 30-8, field 30-9, field 30-10, field 30-17, field 30-18, or field 30-19. Flyndre has been developed with Cawdor and they are tied back to Clyde.

Field 30-12 (with 33.55mmboe of gas condensate) is less than 5km from field 30-13 or field 30-15, less than 10km from Fulmar, Auk, Joanne, field 30-14 or field

30-16 and less than 25km from Clyde, Orion, Joanne, Judy, Harrier, field 30-8, field 30-9, field 30-17, field 30-19, field 29-15 or field 29-16.

Field 30-13 (with 30.16mmboe of oil and gas) is less than 5km from field 30-12 or field 30-15, less than 10km from Fulmar, Auk, field 30-14 or field 30-16 and less than 25km from Clyde, Orion, Flyndre, Judy, Harrier, Jasmine, field 30-8, field 30-9, field 30-17, field 30-18, field 30-19, field 29-15, or field 29-16.

Field 30-14 (with 5mmboe of oil) is less than 10km from field 30-12 or field 30-13 and less than 25km from Joanne, Judy, Jasmine, Harrier, Fulmar, Clyde, Auk, field 30-8, field 30-9, field 30-15, field 30-16, field 29-13, field 29-14, field 29-15, or field 29-16.

Field 30-15 (with 15.54mmboe of oil with a little gas) is less than 5km from Fulmar, field 30-12, field 30-13 or field 30-16, less than 10km from Clyde and less than 25km from Auk, Orion, Flyndre, Cawdor, Joanne, Judy, Harrier, field 30-8, field 30-9, field 30-14, field 30-17, field 30-18, field 30-19, or field 29-16.

Field 30-16 (with 5.69mmboe of oil with a little gas) is less than 5km from Fulmar or field 30-15, less than 10km from Clyde, field 30-12 or field 30-13 and less than 25km from Orion, Auk, Flyndre, Cawdor, Joanne, Judy, Harrier, field 30-14, field 30-17, field 30-18, field 30-19, field 30-20, field 30-21, or field 29-16.

With field 30-12 as a hub the combined reserves of fields 30-13, 30-14, 30-15, 30-16 and 29-16 are 120.9mmboe. Fields 30-12 and 30-15 pass the base hurdle at $70/bbl and 60p/therm giving 34.09mmboe and RNPV @ 10% of £278.69m. Fields 30-13, 30-14, 30-16 and 29-16 fail both hurdles at all prices. The cluster with hub 30-12 passes the base hurdle at $70/bbl and 60p/therm giving 122.23mmboe and RNPV @ 10% of £674.02m. It is also noteworthy that at the

$50 and 35 pence price scenario the RNPV of the cluster exceeds £60 million, and exceeds £281 million at the $60, 40 pence scenario. Field 30-12 is 20km from the SEAL pipeline and less than 20km from the Joanne/Judy Norpipe link.

Table 55

Results with Stand-Alone and Cluster Developments with Field 30-12 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
30-12	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					118.48	122.23	-554.11	60.45
$50/bbl 35p/therm high					118.48	122.23	-554.11	60.45
$60/bbl 40p/therm base					121.43	122.23	-184.09	281.96
$60/bbl 40p/therm high					121.43	122.23	-184.09	281.96
$70/bbl 60p/therm base	49.63	122.23	278.69	674.02	72.30		170.45	
$70/bbl 60p/therm high					121.94	122.23	449.14	674.02

Field 30-17 (with 8mmboe of oil and gas) is less than 5km from Flyndre or Cawdor, less than 10km from field 30-18 or field 30-19 and less than 25km from Orion, Clyde, Fulmar, Joanne, Judy, field 30-9, field 30-10, field 30-11, field 30-12, field 30-13, field 30-15, field 30-16, field 30-20, or field 30-21.

Field 30-18 (with 15.47mmboe of gas condensate) is less than 5km from Flyndre, less than 10km from Cawdor, field 30-17 or field 30-19 and less than 25km from Orion, Clyde, Joanne, Judy, field 30-8, field 30-9, field 30-10, field 30-11, field 30-13, field 30-15, or field 30-16.

Field 30-19 (with 18.46mmboe of oil and gas) is less than 5km from Joanne, less than 10km from Judy, field 30-17 or field 30-18 and less than 25km from Harrier, Jasmine, Orion, Clyde, Fulmar, field 30-8, field 30-9, field 30-10, field 30-11, field 30-12, field 30-13, field 30-15, or field 30-16.

With field 30-19 as a hub the combined reserves of fields 30-11, 30-17 and 30-18 are 56.52mmboe. Fields 30-19 and 30-18 pass the base hurdle at $70/bbl and 60p/therm giving 18.46mmboe and 15.84mmboe respectively, and combined RNPV @ 10% of £178.37m. Fields 30-11, 30-17 fail both hurdles at all prices. The cluster with hub 30-19 passes the base hurdle at $70/bbl and 60p/therm producing 56.52mmboe and RNPV @ 10% of £227.46m. Field 30-1.9 is 5km from the CATS pipeline and less than 5km from the Joanne/Judy Norpipe link.

Table 56

Results with Stand-Alone and Cluster Developments with Field 30-19 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
30-19	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					55.96	52.85	-298.64	-203.46
$50/bbl 35p/therm high					55.96	52.85	-298.64	-203.46
$60/bbl 40p/therm base					56.89	56.52	-87.91	-25.12
$60/bbl 40p/therm high					56.89	56.52	-87.91	-25.12
$70/bbl 60p/therm base	34.30	56.52	178.37	227.46	22.59		32.28	
$70/bbl 60p/therm high					56.89	56.52	210.66	227.46

Field 30-20 (which has 1mmboe of oil and a little gas) is less than 5km from Orion or field 30-21 and less than 25km from Alma, Auk, Clyde, Flyndre, Cawdor, field 30-16, field 30-17, field 30-22, or field 30-23.

Field 30-21 (which has 3.1mmboe of oil) is less than 5km from Orion or field 30-20 and less than 25km from Alma, Auk, Clyde, Flyndre, Cawdor, field 30-16, field 30-17, field 30-22, or field 30-23.

Field 30-22 (with 10.88mmboe of oil with a little gas) is less than 5km from Alma and less than 25km from Orion, field 30-20, field 30-21, or field 30-23. Alma/Galia is an FPSO re-development.

Field 30-23 (with 17.89mmboe of oil) is less than 25km from Alma, field 30-20, field 30-21, or field 30-22.

With field 30-22 as a hub the combined reserves of fields 30-20, 30-21 and 30-23 are 32.87mmboe. Fields 30-22, 30-20, 30-21 and 30-23 fail both hurdles at all prices. The cluster with hub 30-22 passes the base hurdle at $70/bbl and 60p/therm giving 32.87mmboe and RNPV @ 10% of £179.25sm. With the $60, 40 pence scenario the real NPV exceeds £82 million. Field 30-22 is not close to any gas pipelines, but the cluster only has 1mmboe of gas and the field is less than 15km from Norpipe.

Table 57

Results with Stand-Alone and Cluster Developments with Field 30-22 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
30-22	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					34.01	32.87	-214.53	-46.46
$50/bbl 35p/therm high					34.01	32.87	-214.53	-46.46
$60/bbl 40p/therm base					34.01	32.87	-40.78	82.13
$60/bbl 40p/therm high					34.01	32.87	-40.78	82.13
$70/bbl 60p/therm base		32.87		179.25	34.01		117.90	
$70/bbl 60p/therm high					34.01	32.87	117.90	179.25

Quadrant 39 has 1 technical reserve field (with 3.52mmboe of gas). It is not close to any currently producing fields or other technical reserves and would fail both hurdles at all prices.

There are 2 other technical reserves fields (with 5mmboe and 11mmboe) in the CNS but the co-ordinates are unknown. Both fields fail the hurdles at all prices.

Quadrant 41 has 3 technical reserves fields. Field 41-1 (with 1.23mmboe of gas) is less than 10km from field 41-3, and less than 25km from field 41-2 or field 42-4.

Field 41-2 (with 10.22mmboe of gas) is less than 10km from field 41-3 and less than 25km from field 41-1 or field 42-4.

Field 41-3 (with 3mmboe of gas) is less than 10km from field 41-1 or field 41-2 and less than 25km from field 42-4.

19) Quadrant 42

Quadrant 42 has 8 technical reserves fields. Field 42-1 (with 6.23mmboe of gas) is less than 5km from field 42-2 and less than 25km from Breagh or field 42-3.

Field 42-2 (with 0.88mmboe of gas) is less than 5km from field 42-1 and less than 25km from Breagh or field 42-3.

Field 42-3 (with 0.88mmboe of gas) is less than 25km from Breagh, field 42-1, field 42-2, or field 43-2.

With field 42-1 as a hub the combined reserves of fields 42-2 and 42-3 give reserves of 7.99mmboe. Field 42-1 passes the base hurdle at $70/bbl and 60p/therm, giving 6.63mmboe and RNPV @ 10% of £34.43m. Fields 42-2 and

42-3 fail both hurdles at all prices. The cluster with hub 42-1 passes the base hurdle at $70/bbl and 60p/therm giving 8.22mmboe and RNPV @ 10% of £40.60m. Field 42-1 is 10km from the Langeled pipeline and less than 45km from the Breagh pipeline.

Table 58

Results with Stand-Alone and Cluster Developments with Field 42-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
42-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					8.24	7.99	-39.30	-27.86
$50/bbl 35p/therm high					8.24	7.99	-39.30	-27.86
$60/bbl 40p/therm base					8.31	8.22	-21.95	-11.81
$60/bbl 40p/therm high					8.31	8.22	-21.95	-11.81
$70/bbl 60p/therm base	6.63	8.22	34.43	40.60	1.83		4.42	
$70/bbl 60p/therm high					8.46	8.22	38.85	40.60

Field 42-4 (with 12.15mmboe of gas) is less than 25km from field 41-1, field 41-2, or field 41-3.

With field 42-4 as a hub the combined reserves of fields 41-1, 41-2 and 41-3 give 26.6mmboe. Fields 42-4 and 41-2 pass the base hurdle at $70/bbl and 60p/therm, and field 42-2 passes the higher hurdle at $70/bbl and 60p/therm giving 23.19mmboe and 12.69mmboe, and RNPV @ 10% of £135.52m with the base

hurdle and £78.47m with the high hurdle. Fields 41-1 and 41-3 fail both hurdles at all prices. The cluster with hub 42-4 passes the base hurdle at $70/bbl and 60p/therm, giving 27.13mmboe and RNPV @ 10% of £128.50m.

Table 59
Results with Stand-Alone and Cluster Developments with Field 42-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
42-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					26.94	26.60	-63.93	-45.79
$50/bbl 35p/therm high					26.94	26.60	-63.93	-45.79
$60/bbl 40p/therm base					27.39	27.13	-10.02	0.30
$60/bbl 40p/therm high					27.39	27.13	-10.02	0.30
$70/bbl 60p/therm base	23.19	27.13	135.52	128.50	4.4		15.27	
$70/bbl 60p/therm high	12.69		78.47		14.90	27.13	72.32	128.50

Field 42-5 (with 21.44mmboe of gas) is less than 5km from Garrow and less than 25km from Ravenspurn, Whittle, field 43-6, field 43-7, or field 43-9.

Field 42-6 (with 31.76mmboe of gas) is less than 25km from Wollastone *and* it passes the base hurdle at $70 giving 32.27mmboe. The nearest technical reserve is field 41-3 which is 30km away. Field 42-6 is 15km from the Langeled pipeline.

Field 42-7 (with 7.23mmboe of gas) is less than 5km from Cleeton, Neptune, or field 42-8, less than 10 km from Minerva, and less than 25km from Ravenspurn, Whittle, Wollastone, Artemis, Apollo, field 43-9, field 47-1, field 47-2, field 47-3, field 47-4, field 47-5, field 48-1, or field 48-2.

Field 42-8 (with 5mmboe of gas) is less than 5km from Cleeton, Neptune or field 42-7, less than 10 km from Minerva and less than 25km from Ravenspurn, Whittle, Wollastone, Artemis, Apollo), field 43-9. Field 47-1, field 47-2, field 47-3, field 47-4, field 47-5, field 48-1, or field 48-2.

20) Quadrant 43

Quadrant 43 has 12 technical reserves fields. Field 43-1 (with 9.51mmboe of gas) is less than 25km from Trent, field 43-3 or field 43-4.

Field 43-2 (with 26.77mmboe of gas) is less than 25km from Garrow, Kilmar, field 43-3, field 43-4, field 43-6, field 43-7 or field 42-3.

Field 43-3 (with 5.38mmboe of gas) is less than 10 km from Kilmar or field 43-4, and less than 25km from Trent, field 43-1, field 43-2, field 43-6 or field 43-7.

Field 43-4 (with 5.72mmboe of gas) is less than 10 km from field 43-3 and less than 25km from Kilmar, Trent, field 43-1 or field 43-2.

With field 43-4 as a hub the combined reserves of fields 43-1, 43-2 and 43-3 are 48.76mmboe. All fields pass the base hurdle at $70/bbl and 60p/therm giving total RNPV @10% of £241.79m. The cluster with hub 43-4 passes both hurdles at $70/bbl and 60p/therm ,giving 47.96mmboe and RNPV @ 10% of £277.83m. The real NPV@10% also exceeds £65 million at the $60, 40 pence price scenario.

Field 43-4 is less than 5km from the SEAL pipeline and 15km from the Eagles pipeline (ETS).

Table 60
Results with Stand-Alone and Cluster Developments with Field 43-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
43-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					47.60	47.39	-117.86	0.49
$50/bbl 35p/therm high					47.60	47.39	-117.86	0.49
$60/bbl 40p/therm base					48.62	47.96	-27.41	65.96
$60/bbl 40p/therm high					48.62	47.96	-27.41	65.96
$70/bbl 60p/therm base	48.76	47.96	241.79	277.83				
$70/bbl 60p/therm high		47.96		277.83	48.76	47.96	241.79	277.83

Field 43-5 (with 6.09mmboe of gas) is less than 10 km from field 44-1 and less than 25km from Cygnus, Boulton, field 43-8, field 44-2, field 44-3, or field 44-4.

Field 43-6 (with 27.08mmboe of gas) is less than 5km from field 43-7, less than 10 km from Garrow and less than 25km from Kilmar, Johnston, Ravenspurn, field 43-2, field 43-3, field 43-9, field 43-10, or field 42-5.

Field 43-7 (with 13.94mmboe of gas) is less than 5km from field 43-6, less than 10 km from Garrow or Kilmar and less than 25km from Ravenspurn, Johnston, field 43-2, field 43-3, field 43-9, or field 42-5.

Field 43-8 (with 2.28mmboe of gas with a little oil) is less than 25km from Trent, Boulton, field 43-5, field 44-1, or field 44-4.

Field 43-9 (with 5.28mmboe of gas) is less than 5km from Ravenspurn and less than 25km from Garrow, Johnston, Cleeton, Babbage, field 43-6, field 43-7, field 43-10, field 42-5, field 42-7, field 42-8, field 48-1, or field 48-2.

With field 43-6 as a hub the combined reserves of fields 43-7, 43-9 and 42-5 are 67.74mmboe. All fields pass the base hurdle at $70/bbl and 60p/therm giving 69.83mmboe and RNPV @ 10% of £395.46m. Fields 43-7 and 42-5 pass the higher hurdle at $70/bbl and 60p/therm, giving 36.58mmboe and RNPV @ 10% of £234.45m. The cluster with hub 43-6 passes both hurdles at $70/bbl and 60p/therm giving 68.58mmboe and RNPV @ 10% of £359.52m. At the $60, 40 pence scenario the real NPV of the cluster exceeds £91 million. It is over £12 million at the £50, 35 pence case.

Table 61

Results with Stand-Alone and Cluster Developments with Field 43-6 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
43-6	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					68.84	67.76	-86.97	12.74
$50/bbl 35p/therm high					68.84	67.76	-86.97	12.74
$60/bbl 40p/therm base					69.38	68.58	40.23	91.07
$60/bbl 40p/therm high					69.38	68.58	40.23	91.07
$70/bbl 60p/therm base	69.83	68.58	395.46	359.52				
$70/bbl 60p/therm high	36.58	68.58	234.45	359.52	33.24		161.01	

Field 43-10 (with 3.87mmboe of gas) is less than 5 km from Johnston, less than 10km from Babbage, and less than 25km from Ravenspurn, Hoton, field 43-6, field 43-7, field 43-9, field 43-11, field 48-1, field 48-2, field 48-3, field 48-4, field 48-5, field 48-6, or field 48-9.

Field 43-11 (with 17.26mmboe of gas) is less than 25km from Trent, Johnston, Babbage, field 43-10, field 48-4, field 48-5, field 48-6, field 48-7, field 48-8, field 48-9, or field 48-10.

The exact co-ordinates of field 43-12 (which has 15.2mmboe) are unknown. This field passes both hurdles at $70/bbl and 60p/therm.

21) Quadrant 44

Quadrant 44 has 12 technical reserves fields. Field 44-1 (with 40.22mmboe of gas) is less than 10km from field 44-2 or field 43-5 and 25km from Cygnus, Tyne, Jura, field 44-3, 44-4, or field 43-8.

Field 44-2 (with 8.34mmboe of gas) is less than 10km from Cygnus, field 44-1 or field 44-4 and 25km from Tyne, Boulton, field 44-3, or field 44-5.

Field 44-3 (with 6mmboe of gas) is less than 5km from field 44-4, less than 10km from Tyne, and less than 25km from Cygnus, Katy, Wingate, field 44-1, 44-2, 44-5, 44-6, or field 43-5.

Field 44-4 (with 15mmboe of gas) is less than 5km from field 44-3, less than 10km from field 44-2 and less than 25km from Cygnus, Boulton, Tyne, Katy, field 44-5, 44-6, 43-5, or field 43-8.

Field 44-5 (with 5.39mmboe of gas) is less than 10km from Tyne or Katy and less than 25km from Wingate, field 44-3, 44-4, or field 44-6.

Field 44-6 (with 4.85mmboe of gas) is less than 5km from Katy or Wingate and less than 25km from Orca, Tyne, field 44-3, 44-4, or field 44-5.

With field 44-4 as a hub the combined reserves of fields 43-5, 43-8, 44-1, 44-2, 44-3, 44-5 and 44-6 are 87.9mmboe. Field 43-8 fails both hurdles at all prices. All other fields pass the base hurdle at $70/bbl and 60p/therm giving a total of 88.04mmboe, and achieving RNPV @ 10% of £491.80m. Fields 44-4 and 44-1 pass the higher hurdle at $70/bbl and 60p/therm giving 56.38mmboe and achieving RNPV @ 10% of £333.91m on a stand-alone basis. The cluster with

hub 44-4 passes both hurdles at $70/bbl and 60p/therm giving 88.73mmboe and RNPV @ 10% of £499.36m. It is noteworthy that the cluster development achieves a real NPV@10% exceeding £77 million at the $50, 35 pence scenario, and a real NPV exceeding £165 million at the $60, 40 pence scenario. Field 44-4 is less than 5km from the Tyne/Trent pipeline which connects to the Eagles pipeline, and less than 20km to the Murdoch pipeline. Tyne is to be decommissioned and the Theddlethorpe terminal is closed.

Table 62

Results with Stand-Alone and Cluster Developments with Field 44-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
44-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					88.80	87.92	-153.72	77.93
$50/bbl 35p/therm high					88.80	87.92	-153.72	77.93
$60/bbl 40p/therm base					90.01	88.73	10.56	165.13
$60/bbl 40p/therm high					90.01	88.73	10.56	165.13
$70/bbl 60p/therm base	88.04	88.73	491.80	499.36	2.37		9.11	
$70/bbl 60p/therm high	56.38	88.73	333.91	499.36	34.02		167.01	

Field 44-7 (with 7.33mmboe of gas) is less than 25km from Boulton, field 44-8, field 48-7, field 48-10, or field 49-1.

Field 44-8 (with 9.07mmboe of gas) is less than 10km from Ketch and less than 25km from Boulton, field 44-7, 44-9, field 44-10, field 44-11, field 44-12, field 49-1, or field 49-2.

Field 44-9 (with 9.03mmboe of gas with a little oil) is less than 5km from field 44-10, less than 10km from Ketch, field 44-11 or field 44-12 and less than 25km from Orca, Boulton, Wingate, field 44-8, or field 49-2.

Field 44-10 (with 13.42mmboe of gas) is less than 5km from Ketch or field 44-9, less than 10km from field 44-11 or field 44-12 and less than 25km from Orca, Chiswick, Kew, Boulton, Wingate, field 44-8, or field 49-2.

Field 44-11 (with 7mmboe of gas) is less than 5km from Ketch or field 44-12, less than 10km from field 44-9 or field 44-10, and less than 25km from Orca, Chiswick, Boulton, Wingate, field 44-8, field 49-1, or field 49-2.

Field 44-12 (with 20.49mmboe of gas) is less than 5km from Ketch or field 44-11, less than 10km from field 44-9 or field 44-10, and less than 25km from Orca, Chiswick, Boulton, Wingate, field 44-8, or field 49-2.

With field 44-12 as a hub the combined reserves of fields 44-9, 44-10 and 44-11 are 49.94mmboe. All fields pass the base hurdle at $70/bbl and 60p/therm giving 51.13mmboe and RNPV @ 10% of £312.26m. Fields 44-12 and 44-10 pass the higher hurdle at $70/bbl and 60p/therm giving 34.57mmboe and RNPV @ 10% of £220.43m. The cluster with hub 44-12 passes both hurdles at $70/bbl and 60p/therm, giving 50.55mmboe and RNPV @ 10% of £298.62m. The real NPV for the cluster development is positive at the $50, 35 pence case and exceeds £76 million at the $60, 40 pence case. Field 44-12 is less than 25km from the Murdoch pipeline but Theddlethorpe is no longer in operation.

Table 63

Results with Stand-Alone and Cluster Developments with Field 44-12 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
44-12	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					50.59	49.95	-71.56	9.15
$50/bbl 35p/therm high					50.59	49.95	-71.56	9.15
$60/bbl 40p/therm base					50.84	50.55	27.67	76.88
$60/bbl 40p/therm high					50.84	50.55	27.67	76.88
$70/bbl 60p/therm base	51.13	50.55	312.26	298.62				
$70/bbl 60p/therm high	34.57	50.55	220.43	298.62	16.56		91.83	

22) Quadrant 47

Quadrant 47 has 8 technical reserves fields. Field 47-1 (with 3.52mmboe of gas) is less than 5 km from Artemis, Apollo, Minerva, field 47-2 or field 47-3, less than 10km from Eris or field 47-4 and 25km from Mercury, Ceres, Neptune, Cleeton, Ravenspurn, Whittle, Wollastone, field 47-5, field 42-7, or field 42-8.

Field 47-2 (with 2mmboe of gas) is less than 5 km from Artemis, Apollo or field 47-1, less than 10km from Minerva, Eris field 47-3 or field 47-4 and 25km from Mercury, Ceres, Neptune, Cleeton, Whittle, Wollastone, field 47-5, 42-7, or field 42-8.

Field 47-3 (with 4.72mmboe of gas) is less than 5 km from Artemis, Apollo, Minerva or field 47-1, less than 10km from field 47-2 or field 47-4 and 25km from Mercury, Ceres, Neptune, Cleeton, Ravenspurn, Whittle, Wollastone, Eris, West Sole, field 47-5, 42-7, or field 42-8.

Field 47-4 (with 7.96mmboe of gas) is less than 5 km from Apollo or Minerva, less than 10km from Artemis, Eris, field 47-1, field 47-2 or field 47-3 and 25km from Mercury, Ceres, Neptune, Cleeton, Ravenspurn, Helvellyn, West Sole, field 47-5, 42-7, or field 42-8.

Field 47-5 (with 5.23mmboe of gas) is less than 10km from Ceres or field West Sole and 25km from Hoton, Mercury, Neptune, Cleeton, Ravenspurn, Apollo, Artemis, Minerva, Helvellyn, field 47-1, 47-2, field 47-3, field 47-4, field 47-6, field 47-8, field 42-7, 42-8, field 48-1, or field 48-2.

With field 47-4 as a hub the combined reserves of fields 42-7, 42-8, 47-1, 47-2, 47-3 and 47-5 are 35.66mmboe. Fields 47-4, 47-2, 42-8, 47-3 and 47-5 pass the base hurdle at $70/bbl and 60p/therm giving 31.25mmboe and achieving RNPV @ 10% of £155.02m. The cluster with hub 47-4 passes both hurdles at $70/bbl and 60p/therm, giving 36.24mmboe and achieving RNPV @ 10% of £197.14m. The cluster development also achieves a real NPV exceeding £36 million at the $60, 40 pence price scenario. Field 47-4 is less than 15km from the Ravenspurn/Cleeton pipeline.

Table 64

Results with Stand-Alone and Cluster Developments with Field 47-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
47-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					35.95	35.67	-168.16	-22.33
$50/bbl 35p/therm high					35.95	35.67	-168.16	-22.33
$60/bbl 40p/therm base					37.00	36.24	-90.80	36.88
$60/bbl 40p/therm high					37.00	36.24	-90.80	36.88
$70/bbl 60p/therm base	31.25	36.24	155.02	197.14	5.74		21.73	
$70/bbl 60p/therm high		36.24		197.14	37.00		176.75	

Field 47-6 (with 3mmboe of gas) is less than 5km from Helvellyn, or West Sole, less than 10km from field 47-8 and 25km from Amethyst, Malory, Newsham, Hoton, field 47-5, field 47-7, field 48-3, field 48-13, field 48-14, field 48-15, 48-16, or field 48-18.

Field 47-7 (with 4.4mmboe of gas) is less than 5km from Amethyst and 25km from Helvellyn, Ceres, Mercury, field 47-6, field 47-8 or field 48-14.

Field 47-8 (with 7mmboe of gas) is less than 5km from field 48-14, less than 10km from Amethyst, Helvellyn, or field 47-6 and 25km from West Sole, Newsham, Hoton, Ceres, Mercury, field 47-5, field 47-7, field 48-13, field 48-15, 48-16, field 47-17, or field 48-18.

23) Quadrant 48

Quadrant 48 has 31 technical reserves fields. Field 48-1 (with 0.88mmboe of gas) is less than 5 km from field 48-2, less than 10km from Babbage and 25km from West Sole, Hoton, Newsham, Johnston, Ravenspurn, field 48-3, field 48-4, field 48-5, field 48-6, field 47-5, field 43-9, field 43-10, field 42-7, or field 42-8.

Field 48-2 (with 8.21mmboe of gas) is less than 5 km from Ravenspurn or field 48-1, less than 10km from Babbage and 25km from Johnston, Cleeton, Neptune, West Sole, Hoton, field 48-3, field 48-4, field 47-5, field 43-9, field 43-10, field 42-7, or field 42-8.

Field 48-3 (with 8.83mmboe of gas) is less than 5 km from Hoton, less than 10km from Babbage and 25km from West Sole, Newsham, Ravenspurn, Johnston, field 48-1, field 48-2, field 48-4, field 48-5, field 48-6, field 48-8, field 48-9, field 48-11, or field 43-10.

Field 48-4 (with 12mmboe of gas) is less than 5 km from Babbage, less than 10km from Johnston, field 48-5 or field 48-6 and 25km from West Sole, Newsham, Hoton, Ravenspurn, field 48-1, field 48-2, field 48-3, field 48-8, field 48-9, field 43-10, or field 43-11.

Field 48-5 (with 10.3mmboe of gas) is less than 5 km from field 48-6, less than 10km from field 48-4 or field 48-9 and 25km from Babbage, Hoton, Johnston, field 48-1, field 48-2, field 48-7, field 48-3, field 48-8, field 48-10, field 48-12, 43-10, or field 43-11.

Field 48-6 (with 39.35mmboe of gas) is less than 5 km from field 48-5, less than 10km from field 48-4 or field 48-9 and 25km from Babbage, Hoton, Johnston,

field 48-1, field 48-2, field 48-3, field 48-7, field 48-8, field 48-10, field 48-12, field 43-10, or field 43-11.

Field 48-7 (which has 128.79mmboe) is less than 5km from field 48-10 and 25km from field 48-5, field 48-6, field 48-8, field 48-9, field 48-8, field 48-12, field 43-11, or field 44-7.

Field 48-8 (with 12.79mmboe of gas) is less than 10 km from field 48-9 or field 48-12 and 25km from Barque, Hoton, Babbage, field 48-3, field 48-4, field 48-5, field 48-6, field 48-7, field 48-10, field 48-11, or field 43-11.

Field 48-9 (with 7.38mmboe of gas) is less than 10km from field 48-5, field 48-6 or field 44-8 and 25km from Babbage, Johnston, field 48-3, field 48-4, field 48-7, field 48-10, field 48-12, field 43-10, or field 43-11.

Field 48-10 (which has 9.01mmboe) is less than 5km from field 48-7 and 25km from field 48-5, field 48-6, field 48-8, field 48-9, field 48-12, field 43-11, or field 44-7.

With field 48-7 as a hub for field 48-10 the combined reserves are 137.8mmboe. Both fields pass the base hurdle at $70/bbl and 60p/therm giving 140.85mmboe and RNPV @ 10% of £887.53m. Field 48-7 passes the base hurdle at $50/bbl and 35p/therm giving 130.31mmboe and RNPV @ 10% of £286.98m. It also passes both hurdles at $60/bbl and 40p/therm giving 131.24mmboe and RNPV @ 10% of £408.01m. The cluster with hub 48-7 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm giving 140.51mmboe. At the higher hurdle the RNPV @ 10% becomes £366.54m at $60/bbl and 40p/therm and £833.03m at $70/bbl and 60p/therm. The stand-alone fields produce more than the hub at $70/bbl and 60p/therm. Field 48-7 is less than 15km from the Murdoch

pipeline and less than 20km from the SEAL pipeline. Theddlethrope is no longer in operation.

Table 65

Results with Stand-Alone and Cluster Developments with Field 48-7 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
48-7	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base	130.31		286.98		9.38	139.51	-28.05	232.49
$50/bbl 35p/therm high					139.69	139.51	258.92	232.49
$60/bbl 40p/therm base	131.24	140.51	408.01	366.54	9.61		-10.06	
$60/bbl 40p/therm high	131.24		408.01		9.61	140.51	-10.06	366.54
$70/bbl 60p/therm base	140.85	140.51	887.53	833.03				
$70/bbl 60p/therm high	131.24	140.51	838.18	833.03	9.61		49.35	

With field 48-4 as a hub the combined reserves of fields 48-1, 48-2, 48-3, 48-5, 48-6, 48-8, 48-9, 43-10 and 43-11 are 120.87mmboe. Fields 48-4, 48-2, 48-3, 48-5, 48-6, 48-8, 48-9 and 43-11 pass the base hurdle at $70/bbl and 60p/therm giving 122.62mmboe and attaining RNPV @ 10% of £701.68m. Fields 48-4, 48-6, 48-8 and 43-11 pass the higher hurdle at $70/bbl and 60p/therm giving 86.67mmboe and attaining RNPV @ 10% of £513.27m. The cluster with hub 48-4 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm giving 122.21mmboe or 122.99mmboe and RNPV @ 10% of £338.19m at $60/bbl and 40p/therm and £775.01m at $70/bbl and 60p/therm. It passes the higher hurdle at $70/bbl and 60p/therm. The cluster also achieves a real

NPV@10% exceeding £210 million at the $50, 35 pence price scenario. Field 48-4 is less than 10km from the Murdoch pipeline and less than 10km from the Babbage/West Sole pipeline which links to the Dimlington gas terminal. Theddlethrope is no longer in operation.

Table 66

Results with Stand-Alone and Cluster Developments with Field 48-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
48-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					124.98	122.21	-171.56	210.13
$50/bbl 35p/therm high					124.98	122.21	-171.56	210.13
$60/bbl 40p/therm base		122.21		338.19	127.12		55.98	
$60/bbl 40p/therm high		122.21		338.19	127.12		55.98	
$70/bbl 60p/therm base	122.62	122.99	701.68	775.01	4.94		19.53	
$70/bbl 60p/therm high	86.67	122.99	513.27	775.01	40.90		207.94	

Field 48-11 (with 9.77mmboe of gas) is less than 5 km from Barque, less than 10km from Newsham or field 48-18 and 25km from Ensign, Galahad, Mordred, Excalibur, Malory, West Sole, Hoton, field 48-3, field 48-8, field 48-12, field 48-13, field 48-15, field 48-16, or field 48-17.

Field 48-12 (with 16.08mmboe of gas) is less than 10 km from field 48-8 and 25km from Ensign, Galleon (which production till 2034), Barque, field 48-5, field 48-6, field 48-7, field 48-10, field 48-11, or field 48-20.

Field 48-13 (with 4.5mmboe of gas) is less than 5 km from West Sole, Newsham or field 48-15, less than 10km from field 48-14, field 48-16 or field 48-18 and 25km from Malory, Mordred, Excalibur, Galahad, Barque, Hoton, Amethyst, Helvellyn, field 48-3, field 48-11, field 48-17, field 48-22, field 47-6, or field 47-8.

Field 48-14 (which has 1.87mmboe) is less than 5 km from field 48-8, less than 10km from West Sole. field 48-13, field 48-15 or field 48-16 and 25km from Hoton, Newsham, Mordred, Excalibur, Amethyst, Ceres, Helvellyn, field 48-17, field 48-18, field 47-6, or field 47-7.

Field 48-15 (with 14.39mmboe of gas) is less than 5 km from West Sole, Newsham or field 48-13, less than 10km from field 48-14, field 48-16 or field 48-18 and 25km from Malory, Mordred, Excalibur, Galahad, Barque, Hoton, Amethyst, Helvellyn, field 48-3, field 48-11, field 48-17, field 48-22, field 47-6, or field 47-8.

Field 48-16 (with 8.39mmboe of gas) is less than 10km from Malory, field 48-13, field 48-14 or field 48-15 and 25km from Lancelot (which has production till 2024), Excalibur, Mordred, Galahad, Barque, Newsham, West Sole, Amethyst, Helvellyn, field 48-11, field 48-17, field 48-18, field 48-21, field 48-22, field 47-6, or field 47-8.

With field 47-8 as a hub the combined reserves of fields 47-6, 47-7, 48-13, 48-14, 48-15 and 48-16 are 43.57mmboe. Fields 47-7, 47-8, 48-13, 48-15 and 48-16 pass the base hurdle at $70/bbl and 60p/therm giving 39.97mmboe and attains RNPV@ 10% of £218.64m. Field 48-15 passes the higher hurdle at $70/bbl and 60p/therm giving 14.8mmboe and RNPV@ 10% of £93.69m. The cluster with hub 47-8 passes both hurdles at $70/bbl and 60p/therm giving 44.10mmboe attaining RNPV @ 10% of £250.99m. At the $60, 40 pence price case the cluster

development also achieves a real NPV@10% exceeding £62 million. Field 47-8 is less than 10km from the Murdoch pipeline to Theddlethorpe which is due to be decommissioned.

Table 67

Results with Stand-Alone and Cluster Developments with Field 47-8 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
47-8	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					43.85	43.58	-149.82	-6.95
$50/bbl 35p/therm high					43.85	43.58	-149.82	-6.95
$60/bbl 40p/therm base					45.04	44.10	-58.05	62.63
$60/bbl 40p/therm high					45.04	44.10	-58.05	62.63
$70/bbl 60p/therm base	39.97	44.10	218.64	250.99	5.07		18.05	
$70/bbl 60p/therm high	14.80	44.10	93.69	250.99	30.24		143.00	

Field 48-17 (with 2.64mmboe of gas) is less than 5km from Excalibur or Mordred, less than 10 km from Galahad or field 48-22 and 25km from Waveney, Lancelot, Barque, West Sole, Newsham, field 48-11, field 48-13, field 48-14, field 48-15, field 48-16, field 48-18, field 48-21, field 48-23, field 48-26, or field 47-8.

Field 48-18 (with 5.65mmboe of gas) is less than 10 km from Barque, Newsham, West Sole, field 48-11, field 48-13 or field 48-15 and less than 25km from

Malory, Excalibur, Hoton, field 48-3, field 48-14, field 48-16, field 48-17, field 48-22, field 47-6, or field 47-8.

With field 48-11 as a hub the combined reserves of fields 48-12, 48-17 and 48-18 are 34.14mmboe. Field 48-17 fails both hurdles at all prices. Fields 48-11, 48-12 and 48-18 pass the base hurdle at $70/bbl and 60p/therm giving 32.52mmboe and attaining RNPV @ 10%of £188.99m. Field 48-12 passes the higher hurdle at $70/bbl and 60p/therm giving 16.47mmboe and RNPV @ 10% of £104.14m. The cluster with hub 48-11 passes both hurdles at $70/bbl and 60p/therm giving 34.7mmboe and RNPV @ 10% of £187.36m. It is noteworthy that the cluster development produces a real NPV@10% exceeding £33 million at the $60, 40 pence scenario. Field 48-11 is less than 5km from the SEAL pipeline and less than 15km from the Murdoch pipeline to Theddlethorpe.

Table 68

Results with Stand-Alone and Cluster Developments with Field 48-11 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
48-11	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					34.75	34.15	-83.12	-23.55
$50/bbl 35p/therm high					34.75	34.15	-83.12	-23.55
$60/bbl 40p/therm base					35.13	34.70	-14.59	33.27
$60/bbl 40p/therm high					35.13	34.70	-14.59	33.27
$70/bbl 60p/therm base	32.52	34.70	188.99	187.36	2.75		9.97	
$70/bbl 60p/therm high	16.47	34.70	104.14	187.36	18.80		94.82	

Field 48-19 (with 16.2mmboe of gas) is less than 5km from Galleon or Ensign, less than 10 km from Clipper field, Barque or field 48-20 and less than 5km from Skiff, field 48-24, field 48-25 , field 48-29, field 49-9, field 49-10, or field 49-11.

Field 48-20 (with 4.31mmboe of gas) is less than 5km from Ensign, less than 10km from field 48-19 and less than 25km from Galleon, Skiff, Clipper, Barque, field 48-12, field 49-9, field 49-10, or field 49-11.

Field 48-21 (with 15.39mmboe of gas with some oil) is less than 10km from Waveney and less than 25km from Lancelot, Excalibur, Mordred, Malory, field 48-16, field 48-17, field 48-22, field 48-23, or field 48-26.

Field 48-22 (with 2.85mmboe of gas) is less than 5km from Lancelot or Excalibur, less than 10km from Mordred, field 48-17 or field 48-23 and less than 25km from Waveney, Barque, Galahad, Clipper, field 48-13, field 48-15, field 48-16, field 48-18, field 48-21, or field 48-26.

Field 48-23 (with 17.6mmboe of gas) is less than 5km from Lancelot, less than 10km from Excalibur or field 48-22 and less than 25km from Waveney, Clipper, Barque, Galahad, Mordred, field 48-17, field 48-21, field 48-26, field 48-27, or field 48-29.

Field 48-24 (with 9.89mmboe of gas) is less than 5km from field 48-25 or field 48-29, less than 10km from Clipper, Skiff or field 48-30 and less than 25km from Ganymede, Galleon, Barque, field 48-19, field 48-27, field 48-28, field 49-11, field 49-16, or field 49-17.

Field 48-25 (with 12.6mmboe of gas) is less than 5km from field 48-24 or field 48-29, less than 10km from Clipper, Skiff or field 48-30 and less than 25km from Ganymede, Galleon, Barque, field 48-19, field 48-27, field 48-28, field 49-11, field 49-16, or field 49-17.

With field 48-19 as a hub the combined reserves of fields 48-20, 48-24 and 48-25 are 43mmboe. Fields 48-19, 48-20, 48-24 and 48-25 pass the base hurdle at $70/bbl and 60p/therm giving 44.7mmboe and RNPV @ 10% of £285.23m. Field 44-19, 48-24 and 48-25 pass the higher hurdle at $70/bbl and 60p/therm giving 40.22mmboe and RNPV @ 10% of £264.59m. The cluster with hub 48-19 passes both hurdles at $70/bbl and 60p/therm giving 43.53mmboe and RNPV @ 10% of £247.31m. It is noteworthy that the cluster development produces a real NPV@10% exceeding £61 million at the $60, 40 pence scenario. Field 48-19 is

less than 20km from the Clipper/Bacton pipeline and less than 15km from the LOGGS pipeline but this is about to be decommissioned.

Table 69

Results with Stand-Alone and Cluster Development with Field 48-19 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
48-19	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					43.96	43.01	-53.72	-7.52
$50/bbl 35p/therm high					43.96	43.01	-53.72	-7.52
$60/bbl 40p/therm base					44.47	43.53	33.72	61.39
$60/bbl 40p/therm high					44.47	43.53	33.72	61.39
$70/bbl 60p/therm base	44.70	43.53	285.23	247.31				
$70/bbl 60p/therm high	40.22	43.53	264.59	247.31	4.48		20.64	

Field 48-26 (with 6.57mmboe of gas) is less than 5km from field Waveney, less than 10km from Lancelot and less than 25km from Excalibur, Galahad, Mordred, field 48-17, field 48-21, field 48-22, or field 49-23.

With field 48-23 as a hub the combined reserves of fields 48-21, 48-22 and 48-26 are 42.41mmboe. Field 48-23, 48-21 and 48-26 pass the base hurdle at $70/bbl and 60p/therm giving 40.99mmboe and RNPV @ 10% of £265.71m. Field 48-21 and 48-23 pass the higher hurdle at $70/bbl and 60p/therm giving 34mmboe and RNPV @ 10% of £228.11m. The cluster with hub 48-23 passes both hurdles

at $70/bbl and 60p/therm giving 42.93mmboe and RNPV @10% of £254.65m. It is noteworthy that the real NPV for the cluster development is (just) positive at the $50, 35 pence case. With the $60, 40 pence case the real cluster NPV@10% exceeds £68 million. Field 48-23 is less than 5km from the Clipper/Bacton pipeline and less than 10km from the LOGGS pipeline, but this is about to be decommissioned.

Table 70

Results with Stand-Alone and Cluster Developments with Field 48-23 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
48-23	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					43.46	42.42	-52.21	7.94
$50/bbl 35p/therm high					43.46	42.42	-52.21	7.94
$60/bbl 40p/therm base					43.80	42.93	28.94	68.03
$60/bbl 40p/therm high					43.80	42.93	28.94	68.03
$70/bbl 60p/therm base	40.99	42.93	265.71	254.65	2.96		11.10	
$70/bbl 60p/therm high	34.00	42.93	228.11	254.65	9.95		48.70	

Field 48-27 (with 10.34mmboe of gas) is less than 5km from field 48-28 and less than 25km from Clipper, field 48-23, field 48-24, field 48-25, field 48-29, or field 48-30.

Field 48-28 (with 15.42mmboe of gas) is less than 5km from field 48-27 and less than 25km from Clipper, Leman, field 48-24, field 48-25, field 48-29, field 48-30, field 49-16, or field 49-17.

Field 48-29 (with 5.28mmboe of gas) is less than 5km from field 48-24 or field 48-25, less than 10km from Clipper and less than 25km from Skiff, Galleon, field 48-19, field 48-23, field 48-27, field 48-28, field 48-30, field 49-16, or field 49-17.

Field 48-30 (with 10.36mmboe of gas) is less than 10km from field 48-24 or field 48-25 and less than 25km from Leman, Europa, Sinope and Ganymede (which are fields in the Jupiter development), Skiff, Galleon, Clipper, field 48-27, field 48-28, field 48-29, field 49-11, field 49-16, or field 49-17.

The exact co-ordinates of field 48-31 (with 15.87mmboe) are unknown, but it would pass both hurdles at $70/bbl and 60p/therm.

24) Quadrant 49

Quadrant 49 has 23 technical reserves fields. Field 49-1 (with 10mmboe of gas) is less than 25km from Chiswick, Ketch, field 49-2, field 49-5, field 44-7, field 44-8, or field 44-11.

Field 49-2 (with 8.7mmboe of gas) is less than 5km from Ketch, less than 10km from Chiswick and less than 25km from Kew, Orca, field 49-1, field 49-4, field 49-5, field 44-8, field 44-9, field 44-10, field 44-11, or field 44-12.

Field 49-3 (with 4.96mmboe of gas) is less than 5km from field 49-3, less than 10km from Chiswick and less than 25km from Kew, Grove, Cutter or field 49-6.

Field 49-4 (which has 10.19mmboe of gas) is less than 5km from field 49-4, less than 10km from Chiswick and less than 25km from Kew, Grove, Ketch, Cutter, field 49-2, field 49-5, or field 49-6.

Field 49-5 (with 2.78mmboe of gas) is less than 25km from Ketch, Chiswick, Grove, Cutter, Carrack, field 49-1, field 49-2, field 49-4, or field 49-6.

Field 49-6 (with 10.18mmboe of gas) is less than 5km from Cutter, less than 10km from Grove, and less than 25km from Chiswick, Kew, Carrack, field 49-3, field 49-4, or field 49-5.

With field 49-6 as a hub the combined reserves of fields 49-3, 49-4 and 49-5 are 28.12mmboe. Fields 49-6, 49-3 and 49-4 pass the base hurdle at $70/bbl and 60p/therm giving 26.1mmboe and RNPV @ 10% of £139.13m. Field 49-5 fails both hurdles at all prices. The cluster with hub 49-6 passes the base hurdle at $70/bbl and 60p/therm giving 28.69mmboe and RNPV @ 10% of £137.28m. The cluster development produces a very small positive NPV@10% with the 40 pence price case. Field 49-6 is less than 15km from the Cutter/Carrack pipeline which connects to the Sole Pitt system taking gas to Bacton and less than 15km from the Grove/Markham pipeline which takes gas to the Dutch sector. The Markham pipeline is to be decommissioned.

Table 71

Results with Stand-Alone and Cluster Developments with Field 49-6 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
49-6	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					28.31	28.13	-89.64	-45.99
$50/bbl 35p/therm high					28.31	28.13	-89.64	-45.99
$60/bbl 40p/therm base					29.00	28.69	-31.26	2.93
$60/bbl 40p/therm high					29.00	28.69	-31.26	2.93
$70/bbl 60p/therm base	26.10	28.69	139.13	137.28	2.89		10.72	
$70/bbl 60p/therm high					29.00	28.69	149.85	137.28

The exact co-ordinates of fields 49-7 (which has 8.56mmboe) and 49-8 (which has 4.28mmboe) are unknown. Fields 49-7 and 49-8 pass the base hurdle at $70/bbl and 60p/therm giving 8.8mmboe and 4.55mmboe respectively.

Field 49-9 (with 0.86mmboe of gas) is less than 10km from field 49-11 and less than 25km from Wenlock, Skiff, Galleon, Ensign, field 49-10, field 49-12, field 49-13, field 48-19, or field 48-20.

Field 49-10 (with 6.68mmboe of gas) is less than 25km from Wenlock, Skiff, Galleon, Ensign, field 49-9, field 49-11, field 48-19, or field 48-20.

Field 49-11 (with 12.97mmboe of gas) is less than 10km from Galleon or field 49-9 and less than 25km from Sinope, Clipper, Skiff, Ensign, Wenlock, field 49-10, field 49-12, field 49-13, field 49-17, field 48-19, field 48-20, field 48-24, field 48-25, or field 48-30.

Field 49-12 (with 1.32mmboe of gas) is less than 10km from field 49-13 and less than 25km from Brigantine, Sinope, Wenlock, field 49-9, field 49-11, field 49-17, or field 49-18.

Field 49-13 (with 2.41mmboe of gas) is less than 10km from field 49-12 and less than 25km from Brigantine, Calisto, Europa, Sinope, field 49-9, field 49-11, or field 49-18.

With field 49-11 as a hub the combined reserves of fields 49-9, 49-10, 49-12 and 49-13 are 24.25mmboe. Fields 49-11 and 49-10 pass the base hurdle at $70/bbl and 60p/therm, and field 49-11 passes the hurdle at $70/bbl and 60p/therm giving 20.29mmboe or 13.34mmboe, and RNPV @ 10% of £122.06m or £83.73m depending on the hurdle rate. The cluster with hub 49-11 passes the base hurdle at $70/bbl and 60p/therm giving 24.75mmboe and RNPV @ 10% of £115.80m. Field 49-11 is less than 25km from the Wenlock/Indefatigable pipeline which takes gas to Bacton and less than 30km from the Clipper/Bacton pipeline.

Table 72

Results with Stand-Alone and Cluster Developments with Field 49-11 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
49-11	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					24.88	24.26	-69.44	-43.69
$50/bbl 35p/therm high					24.88	24.26	-69.44	-43.69
$60/bbl 40p/therm base					25.06	24.75	-18.81	-1.47
$60/bbl 40p/therm high					25.06	24.75	-18.81	-1.47
$70/bbl 60p/therm base	20.29	24.75	122.06	115.80	4.78		14.74	
$70/bbl 60p/therm high	13.34		83.73		11.72	24.75	53.07	115.80

Field 49-14 (with 25.17mmboe of gas) is less than 5km from Caravel or field 49-15, less than 10km from Shamrock and less than 25km from Brigantine, Sean, field 49-18, field 49-19, or field 49-20.

Field 49-15 (with 7.91mmboe of gas) is less than 5km from field 49- 14, less than 10km from Caravel and less than 25km from Shamrock, Brigantine, Sean, field 49-19, or field 49-20.

Field 49-16 (with 8.23mmboe of gas) is less than 5km from field 49-17 and less than 25km from Clipper, Skiff, Sinope, Calisto, Europa, Leman, field 48-24, field 48-25, field 48-28, field 48-29, or field 48-30.

Field 49-17 (with 0.18mmboe of gas) is less than 5km from field 49-16, and less than 25km from Clipper, Skiff, Galleon, Sinope, Calisto, Europa, Leman, field 49-11, field 49-12, field 48-24, field 48-25, field 48-28, field 48-29, or field 48-30.

With field 48-30 as a hub the combined reserves of fields 48-27, 48-28, 48-29, 49-16 and 49-17 are 49.8mmboe. Fields 48-30, 48-27, 48-28, 48-29 and 49-216 pass the base hurdle at $70/bbl and 60p/therm giving 51.01mmboe and RNPV @ 10% of £286.23m. Field 48-28 passes the higher hurdle at $70/bbl and 60p/therm giving 15.79mmboe and RNPV @ 10% of £99.48m. The cluster with hub 48-30 passes both hurdles at $70/bbl and 60p/therm giving 50.41mmboe and RNPV @ 10% of £294.66. It is noteworthy that the cluster development achieves a small real NPV@10% with the 35 pence gas price, and a real NPV@10% exceeding £72 million at the 40 pence price. Field 48-30 is less than 20km from the Eagles pipeline to Bacton, less than 20km from the Clipper/Bacton pipeline and less than 15km from the LOGGS pipeline but this is about to be decommissioned.

Table 73

Results with Stand-Alone and Cluster Developments with Field 48-30 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
48-30	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					50.17	49.81	-113.97	4.53
$50/bbl 35p/therm high					50.17	49.81	-113.97	4.53
$60/bbl 40p/therm base					51.20	50.41	-14.68	72.26
$60/bbl 40p/therm high					51.20	50.41	-14.68	72.26
$70/bbl 60p/therm base	51.01	50.41	286.23	294.66	0.18		0.34	
$70/bbl 60p/therm high	15.79	50.41	99.48	294.66	35.41		187.10	

With field 49-1 as a hub the combined reserves of fields 44-7, 44-8 and 49-2 are 35.1mmboe. All fields pass the base hurdle at $70/bbl and 60p/therm giving 36.17mmboe and RNPV @ 10% of £193.96m. The cluster with hub 49-1 passes both hurdles at $70/bbl and 60p/therm giving 35.67mmboe and RNPV @ 10% of £195.77m. At the 40 pence price case the real NPV@10% of the cluster development exceeds £39 million. Field 49-1 is 35km from the Murdoch pipeline to Theddlethorpe and less than 45km from the Eagles pipeline.

Table 74

Results with Stand-Alone and Cluster Developments with Field 49-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
49-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					35.39	35.11	-102.22	-19.49
$50/bbl 35p/therm high					35.39	35.11	-102.22	-19.49
$60/bbl 40p/therm base					36.17	35.67	-29.44	39.36
$60/bbl 40p/therm high					36.17	35.67	-29.44	39.36
$70/bbl 60p/therm base	36.17	35.67	193.96	195.77				
$70/bbl 60p/therm high		35.67		195.77	36.17		193.96	

Field 49-18 (with 91.99mmboe of gas) is less than 25km from Ganymede, Sinope, Calisto, Europa, Corvette, Sean, Brigantine, Caravel, field 49-12, field 49-13, field 49-14, field 49-19, or field 49-20.

Field 49-19 (with 25.09mmboe of gas) is less than 5km from Sean, less than 10km from Corvette, and less than 25km from Brigantine, Caravel, Shamrock, field 49-14, field 49-15, field 49-18, or field 49-20.

Field 49-20 (with 16.06mmboe of gas) is less than 5km from Sean and less than 25km from Corvette, Brigantine, field 49-14, field 49-15, field 49-18, field 49-19, field 49-23, or field 50-1.

With field 49-19 as a hub the combined reserves of fields 49-14, 49-15, 49-18 and 49-20 are 166.23mmboe. All fields pass the base hurdle at $70/bbl and 60p/therm giving 169.63mmboe and RNPV @ 10% of £972.51m. Fields 49-18 and 49-20 pass the higher hurdle at $70/bbl and 60p/therm giving 109.52mmboe and RNPV @ 10% of £687.78m. Field 49-18 passes the base hurdle at $60/bbl and 40p/therm giving 92.83mmboe and RNPV @ 10% of £245.33m. The cluster with hub 49-19 passes all hurdles at all prices giving 168.27mmboe, 169.47mmboe or 170.19mmboe respectively, and RNPVs @ 10% of £420.97m, £548.10m or £1128.24m respectively. Field 49-19 is less than 5km from the Brigantine pipeline and less than 15km from the Indefatigable pipeline to Bacton.

Table 75

Results with Stand-Alone and Cluster Developments with Field 49-19 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
49-19	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base		168.27		420.97	167.37		17.33	
$50/bbl 35p/therm high		168.27		420.97	167.37		17.33	
$60/bbl 40p/therm base	92.83	169.47	245.33	548.10	76.56		6.69	
$60/bbl 40p/therm high		169.47		548.10	169.40		252.03	
$70/bbl 60p/therm base	169.63	170.19	972.51	1128.24				
$70/bbl 60p/therm high	109.52	170.19	687.78	1128.24	60.11		284.72	

Field 49-21 (with 11mmboe of gas) is less than 5km from Leman and less than 25km from Hewett, field 49-22, field 53-1, field 53-2, field 53-3, or field 53-4.

Field 49-22 (with 4.91mmboe of gas) is less than 5km from Leman and less than 25km from Corvette, Sinope, Callisto, Europa, field 49-21, field 53-1, field 53-2, field 53-3, field 53-4, or field 53-5.

Field 49-23 (with 30.97mmboe of gas) is less than 10km from Davy East, field 53-7 or field 53-9 and less than 25km from Sean, field 49-20, field 50-1, field 53-5, field 53-6, field 54-1, or field 54-2.

25) Quadrant 50

Quadrant 50 has 2 technical reserves fields. Field 50-1 (with 16.89mmboe of gas) is less than 10km from Davy East or field 54-2, and less than 25km Sean, field 49-20, field 49-23, field 53-6, field 53-7, field 53-9, or field 54-1.

Field 50-2 (which has 3.87mmboe) would fail both hurdles at all prices.

26) Quadrant 53

Quadrant 53 has 10 technical reserves fields. Field 53-1 (with 4.58mmboe of gas) is less than 10km from field 53-4, and less than 25km from Leman, Hewett, field 53-2, field 53-3, field 53-10, field 49-21, or field 49-22.

Field 53-2 (with 2.09mmboe of gas) is less than 5km from Leman or field 53-3, less than 10km from field 53-4, and less than 25km from field 53-1, field 53-5, field 53-10, field 49-21, or field 49-22.

Field 53-3 (with 0.53mmboe of gas) is less than 5km from Leman or field 53-2, less than 10km from field 53-4, and less than 25km from field 53-1, field 53-5, field 53-10, field 49-21, or field 49-22.

Field 53-4 (with 42.95mmboe of gas) is less than 5km from Leman, less than 10km from field 53-1, field 53-2 or field 53-3, and less than 25km from Hewett, field 53-10, field 49-21, or field 49-22.

Field 53-5 (with 11.61mmboe of gas) is less than 25km from Davy East, Leman, field 53-6, field 53-7, field 53-9, field 53-10, field 49-22, or field 49-23.

Field 53-6 (with 4.4mmboe of gas) is less than 10km from field 53-7 or field 54-1 and less than 25km from Davy East, field 53-5, field 53-9, field 54-2, field 50-1, or field 49-23.

Field 53-7 (with 4.4mmboe of gas) is less than 5km from Davy East or field 53-9, less than 10km from field 53-6, field 54-2 or field 49-23 and less than 25km from Sean, field 53-5, field 50-1, or field 54-1.

The exact co-ordinates of field 53-8 (which has 6.89mmboe) are unknown but it would pass the base hurdle at $70/bbl and 60p/therm giving 7.33mmboe.

Field 53-9 (with 27.06mmboe of gas) is less than 5km from Davy East or field 53-7, less than 10km from field 54-2 or field 49-23 and less than 25km from Sean, field 53-5, field 53-6, field 50-1, or field 54-1.

Field 53-10 (with 19.56mmboe of gas) is less than 25km from Leman, field 53-1, field 53-2, field 53-3, field 53-4, or 53-5.

With field 53-4 as a hub the combined reserves of fields 49-21, 49-22, 53-1, 53-2, 53-3 and 53-10 are 85.61mmboe. Fields 53-4, 49-21, 49-22, 53-1 and 53-10 pass the base hurdle at $70/bbl and 60p/therm giving 85.13mmboe and RNPV @ 10% of £498.61m. Fields 53-4, 49-21 and 53-10 pass the higher hurdle at $70/bbl and 60p/therm giving 75.26mmboe and RNPV @ 10% of £451.33m. The cluster with hub 53-4 passes both hurdles at $70/bbl and 60p/therm giving 86.42mmboe and RNPV @ 10% of £479.11m. It is noteworthy that the cluster development achieves a real NPV@10% of over £68 million at the 35 pence case, and a real NPV exceeding £151 million at the 40 pence case. Field 53-4 is less than 5km from the Indefatigable/Bacton pipeline and less than 5km from the Sean/Bacton pipeline.

Table 76

Results with Stand-Alone and Cluster Developments with Field 53-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
53-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					86.08	85.63	-95.59	66.50
$50/bbl 35p/therm high					86.08	85.63	-95.59	66.50
$60/bbl 40p/therm base					87.57	86.42	48.90	151.83
$60/bbl 40p/therm high					87.57	86.42	48.90	151.83
$70/bbl 60p/therm base	85.13	86.42	498.61	479.11	2.72		8.21	
$70/bbl 60p/therm high	75.26	86.42	451.33	479.11	12.59		55.49	

27) Quadrant 54

Quadrant 54 has 2 technical reserves fields. Field 54-1 (with 9.26mmboe of gas) is less than 10km from Davy East, field 53-6 or field 54-2 and less than 25km from field 53-7, field 53-9, field 50-1, or field 49-23.

Field 54-2 (with 8.34mmboe of gas) is less than 5km from Davy East, less then 10km from field 53-7, field 53-9, field 54-1 or field 50-1 and less than 25km from field 53-6, or field 49-23.

With field 53-9 as a hub the combined reserves of fields 53-5, 53-6, 53-7, 50-1, 49-23, 54-1 and 54-2 total 112.93mmboe. All fields pass the base hurdle at $70/bbl and 60p/therm giving 115.72mmboe and RNPV @ 10% of £622.69m. Fields 53-5, 50-1 and 49-23 pass the higher hurdle at $70/bbl and 60p/therm giving 60.87mmboe and RNPV @ 10% of £355.34m. The cluster with hub 53-9 passes both hurdles at $70/bbl and 60p/therm giving 114.91mmboe and RNPV @ 10% of £703.98m. The hub also passes the base hurdle at $60/bbl and 40p/therm giving 114.18mmboe and RNPV @ 10% of £292.24m. At the 35 pence price the cluster also produces a real NPV@10% exceeding £169 million. Field 53-9 is less than 40km from the Sean/Bacton pipeline.

Table 77

Results with Stand-Alone and Cluster Developments with Field 53-9 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
53-9	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					113.90	114.18	-193.45	169.88
$50/bbl 35p/therm high					113.90	114.18	-193.45	169.88
$60/bbl 40p/therm base		114.18		292.24	115.52		14.84	
$60/bbl 40p/therm high					115.52	114.18	14.84	292.24
$70/bbl 60p/therm base	115.72	114.91	622.69	703.98				
$70/bbl 60p/therm high	60.87	114.91	355.34	703.98	54.85		267.35	

There is 1 other technical reserve in the SNS (which has reserves of 15.9mmboe) but the co-ordinates are not known. This field passes the higher hurdle at $70/bbl and 60p/therm giving 16.26mmboe.

28) Quadrant 103

Quadrant 103 has 1 technical reserves field (with 16.63mmboe of gas) but there are no surrounding fields or other discoveries in the area. This field would fail both hurdles at all prices.

29) Quadrant 110

Quadrant 110 has 9 technical reserves fields. Field 110-1 (with 17.36mmboe of gas with a little oil) is less than 5km from Calder, Dalton or field 110-2, less then

10km from South Morecambe and less than 25km from North Morecambe, Millom, Rhyl, Conwy, field 110-3, field 110-4, or field 110-5.

Field 110-2 (with 5.29mmboe of gas) is less than 5km from Dalton, South Morecambe or field 110-1, less then 10km from Calder or North Morecambe and less than 25km from Millom, Rhyl, field 110-3, field 110-4, or field 110-5.

Field 110-3 (with 4.39mmboe of gas with a little oil) is less than 25km from South Morecambe, North Morecambe, Dalton, field 110-1, field 110-2, field 110-4, field 110-5, field 110-9, or field 113-5.

Field 110-4 (with 13.73mmboe of gas) is less than 5km from South Morecambe or field 110-5, less than 10km from Calder and less than 25km from Douglas, Douglas West, Hamilton, Hamilton North, Hamilton East, which are known as the Liverpool Bay fields, Conwy, North Morecambe, Dalton, field 110-1, field 110-2, field 110-3, field 110-8, or field 110-9.

With field 110-1 as a hub the combined reserves of fields 110-2, 110-3 and 110-4 are 40.78mmboe. All fields fail both hurdles at all prices. The cluster with hub 110-1 fails both hurdles at all prices. Field 110-1 is less than 10km from the Dalton pipeline, less than 20km from the South Morecambe pipeline and less than 15km from the Calder pipeline. Two of the South Morecambe inter-field pipelines are about to be decommissioned.

Table 78

Results with Stand-Alone and Cluster Developments with Field 110-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
110-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					40.78	40.79	-368.67	-295.47
$50/bbl 35p/therm high					40.78	40.79	-368.67	-295.47
$60/bbl 40p/therm base					41.97	40.79	-285.63	-225.66
$60/bbl 40p/therm high					41.97	40.79	-285.63	-225.66
$70/bbl 60p/therm base					41.97	40.79	38.91	44.03
$70/bbl 60p/therm high					41.97	40.79	38.91	44.03

Field 110-5 (with 0.53mmboe of gas) is less than 5km from field 110-4, less than 10km from South Morecambe or Hamilton North and less than 25km from Douglas, Douglas West, Hamilton, Hamilton East, Lennox which is also a Liverpool Bay field, Calder, Dalton, North Morecambe, field 110-1, field 110-2, field 110-3, field 110-7, field 110-8, or field 110-9.

The exact co-ordinates of field 110-6 (which has 13.57mmboe of gas) are unknown but it would fail all the hurdles.

Field 110-7 (with 5.7mmboe of oil with very little gas) is less 5km from Lennox, less than 10km from field 110-8 or field 110-9, and less than 25km from Douglas, Douglas West, Hamilton, Hamilton North, Hamilton East or field 110-5.

Field 110-8 (with 8.15mmboe of gas) is less than 5km from Hamilton East, less than 10km from Hamilton, field 110-7 or field 110-9 and less than 25km from Hamilton North, Douglas, Douglas West, Lennox, Conwy, field 110-4, or field 110-5.

Field 110-9 (with 28.62mmboe of oil with some gas) is less than 5km from Hamilton East or Hamilton North, less than 10km from Hamilton, field 110-7 or field 110-8 and less than 25km from Douglas, Douglas West, Lennox, Conwy, South Morecambe, Calder, field 110-3, field 110-4, or field 110-5.

With field 110-9 as a hub the combined reserves of fields 110-5, 110-7 and 110-8 are 43.01mmboe. Field 110-7 passes the base hurdle at $70/bbl and 60p/therm giving 6.32mmboe and RNPV @ 10% of £39.17m. The cluster with hub 110-9 fails both hurdles at all prices but has a substantial NPV@10% with the $70, 60 pence price case. Field 110-9 is less than 10km from the Lennox/Douglas pipeline which takes gas to the Point of Ayr. There is less than 12mmboe of gas in this cluster.

Table 79

Results with Stand-Alone and Cluster Developments with Field 110-9

	mmboe		RNPV @10%		mmboe		RNPV @10%	
110-9	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					43.01	40.43	-230.86	-223.74
$50/bbl 35p/therm high					43.01	40.43	-230.86	-223.74
$60/bbl 40p/therm base					43.60	40.43	-58.06	-70.81
$60/bbl 40p/therm high					43.60	40.43	-58.06	-70.81
$70/bbl 60p/therm base	6.32		39.17		37.55	43.01	107.31	125.93
$70/bbl 60p/therm high					43.87	43.01	146.47	125.93

30) Quadrant 113

Quadrant 113 has 4 technical reserves fields. Field 113-1 (with 152.1mmboe of gas) is less than 10km from Millom, Rhyl, field 113-2 or field 113-3 and less than 25km from North Morecambe, South Morecambe, Dalton, or field 113-4.

Field 113-2 (with 11.64mmboe of gas) is less than 5km from Rhyl or field 113-3, less than10km from Millom or field 113-1 and less than 25km from North Morecambe, South Morecambe, Dalton, field 113-4, or field 113-5.

Field 113-3 (with 15.28mmboe of oil) is less than 5km from Rhyl or field 113-2, less than 10km from field 113-1 and less than 25km from Millom, North Morecambe, South Morecambe, Dalton, field 113-4, or field 113-5.

Field 113-4 (with 3.18mmboe of gas) is less than 10km from field 113-5 and less than 25km from Rhyl, Millom, North Morecambe, South Morecambe, field 113-1, field 113-2, or field 113-3.

Field 113-5 (with 4.09mmboe of gas with very little oil) is less than 10km from field 113-4 and less than 25km from Rhyl, North Morecambe, South Morecambe, field 110-3, field 113-2, or field 113-3.

With field 113-3 as a hub the combined reserves of fields 113-1, 113-2, 113-4 and 113-5 are 186.29mmboe. Field 113-3 passes the base hurdle at $70/bbl and 60p/therm giving 15.28mmboe and RNPV @ 10% of £94.8m. Fields 113-1, 113-2, 113-4 and 113-5 fail both hurdles at all prices. The cluster with hub 113-3 fails both hurdles at all prices. But the cluster has a large real NPV@10% at the $70, 60 pence price case. Field 113-3 is less than 15km from the Dalton pipeline.

Table 80

Results with Stand-Alone and Cluster Developments with Field 113-3 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
113-3	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					186.29	186.33	-1014.33	-812.06
$50/bbl 35p/therm high					186.29	186.33	-1014.33	-812.06
$60/bbl 40p/therm base					188.73	186.33	-694.03	-519.26
$60/bbl 40p/therm high					188.73	186.33	-694.03	-519.26
$70/bbl 60p/therm base	15.28		94.80		173.45	186.33	214.31	388.33
$70/bbl 60p/therm high					188.73	186.33	309.11	388.33

31) Quadrant 154

Quadrant 154 has 1 technical reserves field (which has 61.97mmboe of gas) but there is no surrounding infrastructure and it fails both hurdles at all prices.

32) Quadrant 204

Quadrant 204 has 6 technical reserves fields. Field 204-1 (with 76.38mmboe of oil and gas) is less than 25km from Loyal, or field 204-2, and less than 30km from Foinaven or Schiehallion.

Field 204-2 (with 2.6mmboe of oil) is less than 5km from Foinaven, less than 10km from Schiehallion, and less than 25km from Loyal, field 204-1, field 204-3, field 204-4, field 204-5, field 204-6, or field 205-3.

With field 204-1 as a hub for field 204-2 the combined reserves are 78.98mmboe. Fields 204-1 and 204-2 fail both hurdles at all prices. The cluster with hub 204-1 fails both hurdles at all prices. Field 204-1 is less than 35km from the West of Shetlands gas pipeline to Sullom Voe.

Table 81

Results with Stand-Alone and Cluster Developments with Field 204-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
204-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					78.98	78.99	-273.97	-253.90
$50/bbl 35p/therm high					78.98	78.99	-273.97	-253.90
$60/bbl 40p/therm base					78.98	78.99	-113.63	-97.99
$60/bbl 40p/therm high					78.98	78.99	-113.63	-97.99
$70/bbl 60p/therm base					79.89	79.94	258.08	265.68
$70/bbl 60p/therm high					79.89	79.94	258.08	265.68

Field 204-3 (with 1.26mmboe of gas) is less than 5km from field 204-4, less than 10km from Foinaven or field 204-6, and less than 25km from Schiehallion, field 204-2, or field 204-5.

Field 204-4 (with 13mmboe of oil) is less than 5km from Foinaven or field 204-3 and less than 25km from Schiehallion, Loyal, field 204-2, field 204-5, or field 204-6.

Field 204-5 (with 4.49mmboe of oil) is less than 5km from Schiehallion, less than 10km from Foinaven or Loyal and less than 25km from field 204-2, field 204-3, field 204-4, field 205-3, field 205-4, or field 205-8.

Field 204-6 (with 0.92mmboe of oil) is less than 10km from field 204-3, less than 25km from Foinaven, field 204-2 or field 204-4 and less than 30km from Schiehallion.

With field 204-4 as a hub the combined reserves of fields 204-3, 204-5 and 204-6 are 19.67mmboe. Fields 204-4, 204-3 and 204-5 fail both hurdles at all prices. Field 204-6 passes the base hurdle at $70/bbl and 60p/therm giving 0.92mmboe and RNPV @ 10% of £7.25m. The cluster with hub 204-4 passes the base hurdle at $60/bbl and 40p/therm and $70/bbl and 60p/therm and the higher hurdle at $70/bbl and 60p/therm giving 19.67mmboe and RNPV @ 10% of £99.64m at $60/bbl and 40p/therm and £161.84m at $70/bbl and 60p/therm. Field 204-4 is less than 20km from the West of Shetlands gas pipeline to Sullom Voe but there is only 1.3mmboe of gas in this cluster.

Table 82

Results with Stand-Alone and Cluster Developments with Field 204-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
204-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					19.67	19.67	-100.31	30.89
$50/bbl 35p/therm high					19.67	19.67	-100.31	30.89
$60/bbl 40p/therm base		19.67		99.64	19.72		1.96	
$60/bbl 40p/therm high					19.72	19.67	1.96	99.64
$70/bbl 60p/therm base	0.92	19.67	7.25	161.84	18.80		85.64	
$70/bbl 60p/therm high		19.67		161.84	19.72		92.89	

33) Quadrant 205

Quadrant 205 has 8 technical reserves fields. Field 205-1 (with 6.19mmboe of oil) is less than 25km from Tormore, Laggan, Clair, or field 206-4.

Field 205-2 (with 43.96mmboe of gas) is less than 25km from Clair ,or field 206-4.

Field 205-3 (with 240.42mmboe of oil with some gas) is less than 5km from field 205-4, less than 10km from Schiehallion and less than 25km from Loyal, Foinaven, field 205-5, field 205-8, or field 204-2.

Field 205-4 (with 2.37mmboe of oil) is less than 5km from field 205-3 and less than 25km from Schiehallion, Loyal, Foinaven field 205-5, field 205-8, or field 204-5.

Field 205-5 (with 20.01mmboe of gas) is less than 25km from field 205-3, field 205-4 ,or field 205-8.

Field 205-6 (with 6.34mmboe of oil) is less than 5km from Solan or field 205-7 and less than 25km from field 205-8.

With field 205-3 as a hub the combined reserves of fields 205-4 and 205-5 are 262.8mmboe. Field 205-3 and 205-4 pass the base hurdle at $70/bbl and 60p/therm giving 242.79mmboe and RNPV @ 10% of £1486.98m. Field 205-3 passes the higher hurdle at $70/bbl and 60p/therm and the base hurdle at $60/bbl and 40p/therm giving 240.42mmboe and RNPV @ 10 % of £1465.93m or £904.50m. Field 205-5 fails both hurdles at all prices. The cluster with hub 205-3 passes the base hurdle at $70/bbl and 60p/therm, giving 260.18mmboe and RNPV @ 10% of £1318.06m. It is noteworthy that at the $50, 30 pence case the real NPVs@10% of the cluster are substantially positive, and very large with the $60, 40 pence case though it fails the hurdle. Field 205-3 is less than 5km from the West of Shetlands gas pipeline to Sullom Voe.

Table 83

Results with Stand-Alone and Cluster Developments with Field 205-3 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
205-3	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					259.43	252.29	184.83	126.27
$50/bbl 35p/therm high					259.43	252.29	184.83	126.27
$60/bbl 40p/therm base	240.42		904.50		22.85	256.50	-155.70	675.38
$60/bbl 40p/therm high					263.28	256.50	748.80	675.38
$70/bbl 60p/therm base	242.79	260.18	1486.98	1318.06	20.49		-14.36	
$70/bbl 60p/therm high	240.42		1465.93		22.85	260.18	6.70	1318.06

Field 205-7 (with 39.3mmboe of oil) is less than 5km from Solan or field 205-6, and less than 25km from field 205-8.

Field 205-8 (with 20mmboe of oil) is less than 25km from Schiehallion, Solan, field 205-3, field 205-4, field 205-5, field 205-6, field 205-7, or field 204-5.

With field 205-7 as a hub the combined reserves of fields 205-6 and 205-8 are 65.64mmboe. Field 205-7 passes the base hurdle at $70/bbl and 60p/therm giving 39.3mmboe and RNPV @ 10% of £220.48m. Fields 205-6 and 205-8 fail both hurdles at all prices. The cluster with hub 205-7 passes the base hurdle at $70/bbl and 60p/therm giving 65.64mmboe and RNPV @ 10% of £398.04m. The cluster

achieves a real NPV of over £36 million at the $50 pence and over £238 million at the $60 price. There is no gas in this cluster.

Table 84

Results with Stand-Alone and Cluster Developments with Field 205-7 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
205-7	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					65.64	65.64	-149.82	36.88
$50/bbl 35p/therm high					65.64	65.64	-149.82	36.88
$60/bbl 40p/therm base					65.64	65.64	146.06	238.28
$60/bbl 40p/therm high					65.64	65.64	146.06	238.28
$70/bbl 60p/therm base	39.30	65.64	220.48	398.04	26.34		144.45	
$70/bbl 60p/therm high					65.64	65.64	364.93	398.04

34) Quadrant 206

Quadrant 206 has 5 technical reserves fields. Field 206-1 (with 7.45mmboe of gas with a little oil) is less than 5km from Laggan or field 214-4, less than 25km from Tormore or field 214-5, and less than 30km from Clair, Edradour.

Field 206-2 (with 5mmboe of oil) is less than 5km from Edradour, less than 10km from field 206-3 and less than 25km from Glenlivet, field 206-5, field 207-1, or field 214-6.

Field 206-3 (with 14mmboe of oil) is less than 10km from Edradour, field 206-2 or field 207-1 and less than 25km from Clair, Glenlivet, or field 206-5.

Field 206-4 (with 4.07mmboe of gas) is less than 5km from Clair and less than 25km from field 205-1, or field 205-2.

With field 206-4 as a hub the combined reserves of fields 205-1 and 205-2 are 54.22mmboe. Fields 206-4 and 205-2 fail both hurdles at all prices. Field 205-1 passes the base hurdle at $70/bbl and 60p/therm giving 6.19mmboe and RNPV @ 10% of £57.19m. The cluster with hub 206-4 passes the base hurdle at $70/bbl and 60p/therm, giving 54.88mmboe and RNPV @ 10% of £215.60m. Field 206-4 is less than 15km from the West of Shetlands gas pipeline.

Table 85

Results with Stand-Alone and Cluster Developments with Field 206-4 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
206-4	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					54.22	54.23	-338.57	-181.66
$50/bbl 35p/therm high					54.22	54.23	-338.57	-181.66
$60/bbl 40p/therm base					54.38	54.23	-222.42	-75.07
$60/bbl 40p/therm high					54.38	54.23	-222.42	-75.07
$70/bbl 60p/therm base	6.19	54.88	57.19	215.60	48.20		71.95	
$70/bbl 60p/therm high					54.38	54.88	129.15	215.60

Field 206-5 (with 30.9mmboe of oil) is less than 10km from Clair and less than 25km from field 206-2, field 206-3, or field 207-1.

There is one technical reserve field (which has 16.08mmboe of oil and gas) in Quadrant 207. It is less than 10km from field 206-3, and less than 25km from Edradour, field 206-2, field 206-5, or field 214-6.

With field 206-2 as a hub the combined reserves of fields 206-3, 206-5 and 207-1 are 65.98mmboe. All fields fail both hurdles at all prices. The cluster with hub 206-2 passes the base hurdle at $70/bbl and 60p/therm giving 65.99mmboe and RNPV @ 10% of £296.16m. The cluster also produces a real NPV@10% exceeding £101 million at the $60, 40 pence case. Field 206-2 is less than 5km from the Glenlivet/Laggan link and less than 10km from the Laggan/Tormore pipeline.

Table 86

Results with Stand-Alone and Cluster Developments with Field 206-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
206-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					65.91	65.99	-352.32	-104.98
$50/bbl 35p/therm high					65.91	65.99	-352.32	-104.98
$60/bbl 40p/therm base					66.29	65.99	-78.20	101.61
$60/bbl 40p/therm high					66.29	65.99	-78.20	101.61
$70/bbl 60p/therm base		65.99		296.16	66.29		230.10	
$70/bbl 60p/therm high					66.29	65.99	230.10	296.16

35) Quadrant 208

Quadrant 208 has 3 technical reserves fields. Field 208-1 (with 15.05mmboe of oil) is less than 5km from field 208-2 and less than 25km from field 208-3.

Field 208-2 (with 54.57mmboe of gas) is less than 5km from field 208-1 and less than 25km from field 208-3.

Field 208-3 (with 24.42mmboe of gas) is less than 25km from field 208-1 or field 208-2.

With field 208-2 as a hub the combined reserves of fields 208-1 and 208-3 are 94.05mmboe. All fields fail both hurdles at all prices. The cluster with hub 208-

2 fails both hurdles at all prices. But at the $70, 60 pence case the real NPV@10% exceeds £300 million. Field 208-2 is more than 70km from the West of Shetlands pipeline.

Table 87

Results with Stand-Alone and Cluster Developments with Field 208-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
208-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					94.05	94.07	-589.56	-303.61
$50/bbl 35p/therm high					94.05	94.07	-589.56	-303.61
$60/bbl 40p/therm base					94.05	94.07	-382.22	-127.40
$60/bbl 40p/therm high					94.05	94.07	-382.22	-127.40
$70/bbl 60p/therm base					94.05	94.94	185.39	309.04
$70/bbl 60p/therm high					94.05	94.94	185.39	309.04

36) Quadrant 210

Quadrant 210 has one technical reserves field (with 7.31mmboe of oil) which is less than 5km from Falcon, Tern or field 211-6 and less than 25km from Cormorant, Otter, Fionn, Cladhan, Barra and Harris (which are part of the Western Isles development), field 211-7, field 211-8, field 211-9, or field 211-11.

37) Quadrant 211

Quadrant 211 has 13 technical reserves fields. Field 211-1 (which has 13.03mmboe of gas) is less than 5km from Magnus, less than 10km from field

211-4, and less than 25km from Penguins, Don, field 211-2, field 211-3, or field 211-5.

Field 211-2 (which has 7.22mmboe of oil with very little gas) is less than 5km from Penguins, field 211-3, field 211-4 or field 211-5, less than 10km from Magnus and less than 25km from Don, or field 211-1.

Field 211-3 (which has 4.18mmboe of oil) is less than 5km from field 211-4, less than 10km from Magnus, Penguins, field 211-2 or field 211-5 and less than 25km from Don, Ythan, or field 211-1.

Field 211-4 (which has 6.83mmboe of oil) is less than 5km from Penguins, field 211-2, field 211-3 or field 211-5, less than 10km from Magnus or field 211-1 and less than 25km from Don, or Ythan.

Field 211-5 (which has 4.19mmboe of gas condensate) is less than 5km from Penguins, field 211-2 or field 211-4, less than 10km from Magnus or field 211-3 and less than 25km from Don, Ythan or field 211-1.

With field 211-1 as a hub the combined reserves of fields 211-2, 211-3, 211-4 and 211-5 are 35.45mmboe. All fields fail both hurdles at all prices. The cluster with hub 211-1 fails both hurdles at all prices. But, at the $70, 60 pence case the real NPVs@10% are substantially positive. Field 211-1 is less than 20km from the Magnus/Sullom Voe pipeline, less than 20km from the Northern Leg Gas Pipeline and less than 20km from the Magnus/Ninian oil pipeline.

Table 88

Results with Stand-Alone and Cluster Developments with Field 211-1 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
211-1	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					35.45	32.62	-263.25	-238.86
$50/bbl 35p/therm high					35.45	32.62	-263.25	-238.86
$60/bbl 40p/therm base					35.82	35.46	-116.75	-121.36
$60/bbl 40p/therm high					35.82	35.46	-116.75	-121.36
$70/bbl 60p/therm base					35.82	35.46	110.13	62.63
$70/bbl 60p/therm high					35.82	35.46	110.13	62.63

Field 211-6 (which has 2.6mmboe of oil) is less than 5km from Tern or field 210-1, less than 10km from Cormorant or field 211-7 and less than 25km from Don, Ythan, Deveron, Thistle, Fionn, Darwin, Pelican, Hudson, field 211-8, field 211-9, or field 211-11.

Field 211-7 (which has 4mmboe of oil) is less than 5km from Cormorant, less than 10km from Fionn or field 211-6 and less than 25km from Tern, Otter, Darwin, Thistle, Deveron, Ythan, Don, field 211-8, field 211-9, field 211-10, field 211-11, or field 210-1.

Field 211-8 (which has 3.5mmboe of oil) is less than 5km from Cormorant, less than 10km from Fionn, Darwin or field 211-9, and less than 25km from Statjford,

Thistle, Tern, Cladhan, Pelican, field 211-6, field 211-7, field 211-10, field 211-11, field 211-12, field 211-13, field 210-1, or field 3-1.

Field 211-9 (which has 16.02mmboe of oil with very little gas) is less than 5km from Fionn, less than 10km from Cormorant, field 211-8, field 211-10 or field 211-11 and less than 25km from Tern, Don, Ythan, Deveron, Thistle, Statjford, Darwin, field 211-6, field 211-7, field 211-11, field 211-12, field 211-13, or field 210-1.

Field 211-10 (which has 6.69mmboe of oil) is less than 10km from Fionn, field 211-9 or field 211-11 and less than 25km from Cormorant, Thistle, Deveron, Statjford, Darwin, field 211-7, field 211-8, field 211-12, or field 211-13.

Field 211-11 (which has 17.24mmboe of oil) is less than 5km from Fionn, less than 10km from Cormorant, Thistle, field 211-9 or field 211-10 and less than 25km from Don, Ythan, Deveron, Statjford, Darwin, field 211-6, field 211-7, field 211-8, field 211-12, field 211-13, or field 210-1.

Field 211-12 (which has 5mmboe of oil) is less than 5km from Darwin or Pelican, less than 10km from Lyell, field 211-13 or field 3-1 and less than 25km from Ninian, Orlando, Strathspey, Fionn, Cormorant, field 211-8, field 211-9, field 211-10, field 211-11, or field 3-2.

Field 211-13 (which has 12mmboe of oil) is less than 10km from field 211-12 and less than 25km from Ninian, Lyell, Pelican, Alwyn North, Strathspey, Statjford, Fionn, Cormorant, Darwin, field 211-8, field 211-9, field 211-10, field 211-11, field 211-12, field 3-1, field 3-2, or field 3-3.

With field 211-9 as a hub the combined reserves of fields 210-1, 211-6, 211-7, 211-8, 211-10, 211-11, 211-12 and 211-13 are 74.37mmboe and, if field 3-1 can be linked via field 211-13, the reserves increase to 75.71mmboe. Fields 211-9, 210-1, 211-11 and 211-13 pass the base hurdle at $70/bbl and 60p/therm giving 52.58mmboe and RNPV @ 10% of £363.50m. Fields 211-6, 211-7, 211-8, 211-10, 211-12 and 3-1 fail both hurdles at all prices. Field 211-11 passes the higher hurdle at $70/bbl and 60p/therm and the base hurdle at $60/bbl and 40p/therm giving 17.24mmboe and RNPV @ 10% of £95.03m at $60/bbl and 40p/therm or £147.97m at $70/bbl and 60p/therm. The clusters with hubs 211-9a and 211-9b pass both hurdles at $70/bbl and 60p/therm giving 74.37mmboe and 75.71mmboe, and RNPVs @ 10% of £575.18m and £593.13m. Both clusters also pass the base hurdle at $60/bbl and 40p/therm giving RNPVs @ 10% of £382.67m for 211-9a and £397.32m for hub 211-9b. With hub211-9a it is noteworthy that the cluster development produces a real NPV@10% exceeding £197 million at the $50 and 35 pence price case, and an NPV of over £382 million at the $60, 40 pence case. With hub 211-9b the real NPV is £209 million at $50, 35 pence prices and £397 million at $60, 40 pence prices. There is less than 0.5mmboe of gas in this cluster. Field 211-9 is less than 20km from the Northern Leg Gas Pipeline, less than 5km from the Brent pipeline, and less than 5km from the Magnus/Ninian pipeline to Sullom Voe.

Table 89

Results with Stand-Alone and Cluster Developments with Field 211-9a as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
211-9a	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					74.37	74.37	-216.45	197.04
$50/bbl 35p/therm high					74.37	74.37	-216.45	197.04
$60/bbl 40p/therm base	17.24	74.37	95.03	382.67	57.13		58.22	
$60/bbl 40p/therm high					59.77	74.37	153.26	382.67
$70/bbl 60p/therm base	52.58	74.37	363.50	575.18	21.79		91.60	
$70/bbl 60p/therm high	17.24	74.37	147.97	575.18	57.13		307.14	

Table 90
Results with Stand-Alone and Cluster Developments with Field 211-9b as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
211-9b	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					75.71	75.71	-228.52	209.54
$50/bbl 35p/therm high					75.71	75.71	-228.52	209.54
$60/bbl 40p/therm base	17.24	75.71	95.03	397.32	58.47		53.87	
$60/bbl 40p/therm high					61.11	75.71	148.90	397.32
$70/bbl 60p/therm base	52.58	75.71	363.50	593.13	23.13		94.96	
$70/bbl 60p/therm high	17.24	75.71	147.97	593.13	58.47		310.50	

38) Quadrant 213

Quadrant 213 has one technical reserves field (which has 20mmboe of oil) but the nearest field, Laggan, is 45km away. This field would fail both hurdles at all prices.

39) Quadrant 214

Quadrant 214 has 6 technical reserves fields. The exact co-ordinates of field 214-1 (which has 497.74mmboe of oil with some gas) are unknown. It would pass both hurdles at $60/bbl and 40p/therm and $70/bbl and 60p/therm and the base hurdle at $50/bbl and 35p/therm.

Field 214-2 (which has 49.88mmboe of gas) is less than 25km from field 214-3.

Field 214-3 (which has 12.5mmboe of gas) is less than 25km from field 214-2. With field 214-2 as a hub for field 214-3 the combined reserves are 62.38mmboe. Fields 214-2 and 214-3 fail both hurdles at all prices as does the cluster with hub 214-2. But the real NPVs@10% are substantially positive at £115 million for the cluster development at the $70, 60 pence case. Field 214-2 is not near any pipelines.

Table 91

Results with Stand-Alone and Cluster Developments with Field 214-2 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
214-2	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					62.38	62.40	-403.86	-342.03
$50/bbl 35p/therm high					62.38	62.40	-403.86	-342.03
$60/bbl 40p/therm base					62.38	62.38	-296.57	-248.71
$60/bbl 40p/therm high					62.38	62.38	-296.57	-248.71
$70/bbl 60p/therm base					62.73	62.38	105.94	115.04
$70/bbl 60p/therm high					62.73	62.38	105.94	115.04

Field 214-4 (which has 10.18mmboe of gas) is less than 5km from field 206-1, less than 10km from field 214-5 and less than 25km from Laggan or Edradour.

Field 214-5 (which has 19.07mmboe of oil and gas) is less than 10km from field 214-4 and less than 25km from Laggan, Edradour, Glenlivet, field 214-6, or field 206-1.

Field 214-6 (which has 14.49mmboe of gas) is less than 10km from Glenlivet and less than 25km from Edradour, field 214-5, field 206-2, or field 207-1.

With field 214-5 as a hub the combined reserves of fields 206-1, 214-4 and 214-5 are 51.2mmboe. Fields 214-5, 206-1, 214-4 and 214-6 fail both hurdles at all prices. The cluster with hub 214-5 passes the base hurdle at $70/bbl and 60p/therm giving 51.82mmboe and RNPV @ 10% of £267.49m. The cluster development also produces a real NPV@10% exceeding £31 million at the $60, 40 pence case. Field 214-5 is less than 25km from the Glenlivet/Laggan pipeline and less than 25km from the Laggan/Tormore pipeline.

Table 92

Results with Stand-Alone and Cluster Developments with Field 214-5 as Hub

	mmboe		RNPV @10%		mmboe		RNPV @10%	
214-5	Stand-alone Pass	Cluster Pass	Stand-alone £m Pass	Cluster £m Pass	Stand-alone Fail	Cluster Fail	Stand-alone £m Fail	Cluster £m Fail
$50/bbl 35p/therm base					50.05	51.21	-514.92	-89.73
$50/bbl 35p/therm high					50.05	51.21	-514.92	-89.73
$60/bbl 40p/therm base					51.49	51.21	-369.70	31.41
$60/bbl 40p/therm high					51.49	51.21	-369.70	31.41
$70/bbl 60p/therm base		51.82		267.49	52.19		1.12	
$70/bbl 60p/therm high					52.19	51.82	1.12	267.49

40) Quadrant 217

Quadrant 217 has one technical reserves field (which has 296.4mmboe of oil) but there are no fields or discoveries in the area. This field passes both hurdles at $60/bbl and 40p/therm and $70/bbl and 60p/therm giving 296.4mmboe. This field is not near any pipelines.

5. Summary and Conclusions

There are 401 undeveloped discoveries in the UKCS without serious development plans in place. These are here termed technical reserves. A key objective of the industry and the Oil and Gas Authority (OGA) is to maximise economic recovery. It is important to understand the potential contribution which

these technical reserves can make to MER UK. In this paper the key features of these fields were described and a detailed analysis was undertaken of the prospective economic production and investment returns from these fields examined on (a) stand-alone and (b) cluster development basis. The great majority of the fields are very small, and the idea of forming clusters and thus obtaining economies through a common infrastructure was central to the analysis.

The clusters were designed on a geographic basis such that the distances between fields could readily permit tie-back investments to a hub facility to be undertaken. A distance of up to 25 km was taken to be readily achievable. The detailed geographic mapping exercise for the design of possible clusters was undertaken on a Quadrant basis, but it was appreciated that plausible clusters are not necessarily related to Quadrants. Hence other combinations of fields were analysed. Sometimes a field could be in more than one plausible cluster. Altogether 80 hubs were identified as being plausible from a geographical viewpoint. Attention was given to the proximity or otherwise of major existing infrastructure of trunk pipelines from the possible cluster fields.

The study then examined the comparative economics of developing the fields on (a) a stand-alone basis and (b) cluster basis. It was acknowledged that the technical reserves fields would have unit development costs higher than those applicable to the current generation of probable and possible fields. A premium of $5 per boe above the average for these fields was thus employed for the individual technical reserves in the study. The Monte Carlo technique was employed to postulate a range of unit development costs for the individual fields. This was modified to take into account the likelihood that the unit development costs would be lower the larger the size of reserves reflecting conventional economies of scale. Finally, recognition was made of the common infrastructure costs as well as the savings from a cluster development.

Every field in the category of technical reserves was given a number and a detailed geographic mapping exercise was conducted to establish plausible clusters. It became clear that a field could sensibly be considered as part of different clusters. The comparative economics of each of these was studied in order to discover the most profitable cluster. The cases where a field could participate in different clusters are shown in Table 93.

Table 93

Fields Named in Different Clusters

Field 3-6 is named in 2 clusters, 2-1b and 3-9

Field 3-10 is named in 2 clusters, 2-1b and 3-16a

Field 9-14 is named in 2 clusters, 9-9b and 9-8a

Field 16-20 is named in 2 clusters, 16-17b and 16-20

Field 28-1 is named in 3 clusters, 21-20b, 21-29c and 28-2

Three price scenarios were employed in the economic modelling, namely (a) $50 per barrel and 35 pence per therm, (b) $60 and 40 pence, and (c) $70 and 60 pence. All are in real terms as are the investment and operating costs. It was assumed that the licensees were not in a tax-paying position at the time of the investments. Thus they employed the Ring Fence Expenditure Supplement (RFES) for Supplementary Charge in assessing investments. It was also assumed that the investors were equity holders in the fields and thus the complications of complex third party tariff arrangements were avoided.

The investment hurdle employed in the base case was post-tax NPV@10% / pre-tax Investment ≥ 0.3. This reflects the reality of capital rationing. A case with a very high hurdle of NPV/I ≥ 0.5 was also employed. The results highlighted are (a) the aggregate production and the post-tax NPVs@10% for the stand-alone

fields and the clusters which pass the hurdles. In addition, the aggregate production and post-tax NPVs@10% are shown for fields and clusters which failed the investment hurdles noted above. These indicate a significant number of cases where the post-tax NPVs are significantly positive even when they fail the hurdle rates specified above. Key results are shown in Table 94 for aggregate production and post-tax NPVs@10% which pass the NPV/I ≥ 0.3 hurdle.

Table 94

Results for Stand-Alone and Cluster Developments which Pass Hurdle of NPV/I ≥ 0.3

Prices	Aggregate Production (bn boe)		Aggregate NPVs@10% (£ bn. 2019)	
	Stand-Alone	Cluster	Stand-Alone	Cluster
$50, 35p	0.13	1.20	0.287	4.27
$60, 40p	1.00	2.67	4.14	12.07
$70, 60p	3.95	5.68	24.28	34.23

The results show that under the $50, 35 pence price scenario one field passes the investment hurdle. With cluster developments 6 clusters pass the hurdle with resulting aggregate production of 1.2 billion boe. The aggregate, lifetime NPVs@10% to investors were £4.27 billion. With the $60, 40 pence price scenario in the field stand-alone case aggregate production is 1.0 bn boe while with cluster developments it became 4.14 bn boe. Aggregate NPVs to investors are £2.67 bn in the stand-alone case and £12.07 bn in the clusters case. There were 20 cluster developments which passed the NPV/I ≥ 0.3 hurdle. With the $70, 60 pence price scenario aggregate production is 3.95 bn boe in the stand-alone case, and 5.7 bn boe in the cluster case. The aggregate lifetime NPVs@10% to investors are £24.28 bn in the stand-alone case and £34.23 bn in the cluster case. In this scenario 69 clusters passed the NPV/I ≥ 0.3 hurdle. There is also

significant production under the $60, 40 pence and $70, 60 pence price scenarios which are not part of any cluster.

The results clearly indicate that cluster developments can significantly enhance economic recovery from the UKCS. Recovery could be higher still if investment hurdles were lower. The study found that there were many cases where the NPVs@10% were significantly positive but still failed the NPV/I $\geq$ 0.3 hurdle.

A further key finding of the study is the continuing substantial oil and gas price sensitivity of activity in the UKCS. This has long been recognised in general terms, but the study provides very clear evidence that major discoveries made using $50 prices for investment screening purposes will produce radically lower development and long-term production compared to prices of $70.

A key purpose of the study was to exhibit the scope for cluster developments throughout the main producing regions of the UKCS. Simplifying assumptions inevitably had to be made. Thus, the complexities of third party tariffing are not discussed. Nor are the extra problems of sequential field developments when the common infrastructure costs have to be shared among investors whose fields came on stream at quite different dates[1].

The effective employment of clusters will also depend on the extent to which the infrastructure of large trunk pipelines and terminals continues to be available. The absence of this would increase costs, and the present study demonstrates that

[1] The present authors have conducted a detailed study of the effects of different schemes for sharing common infrastructure costs among licensees with sequential and simultaneous developments. See A.G. Kemp and L. Stephen "The Economics of Infrastructure Cost Sharing with Cluster Type Developments in the UKCS", North Sea Study Occasional Paper No. 53, November 1995, pp. 98, University of Aberdeen Department of Economics, available from the authors

projects can readily become uneconomic when the operating environment deteriorates.

It should be noted, however, that the assumptions regarding the saving in costs from clusters in the present study are quite cautious. The premium on investment costs employed in the modelling is quite substantial. This gives support to the idea that the costs of cluster developments could become lower than indicated in this study.