8 EFFECTS ON THE SEABED AND MARINE ECOSYSTEMS

8.1 EFFECTS ON SEDIMENTS AND BENTHIC COMMUNITIES

8.1.1 DESCRIPTION OF IMPACTS

Operations to install the WTGs and the subsea umbilicals will disturb seabed sediments, and this may disrupt areas of the benthic community and smother nearby sites with resettled sediment. The bases of the WTGs and the concrete mattresses placed on the seabed to protect unburied sections of the umbilicals will cover the seabed and the benthic communities for the duration of the project.

8.1.2 MAGNITUDE OF EFFECTS

Sensitivity of the site

The characteristics and status of the benthic communities in and around the Beatrice field have been surveyed and assessed on several occasions, and a site-specific seabed survey was carried out at the Demonstrator site in October 2005 (Section 4.2.2). There are no designated sites or species on the seabed in the area of the WTGs, and beds of the horse mussel *Modiolus modiolus* were found (Sections 4.2.7 and 4.3.1). The characteristics of the seabed sediments in the area of the Beatrice field, where the water depth ranges from 40m to 50m, are relatively uniform, and there are no remarkable, threatened or vulnerable physical features or habitats (Talisman, 2003). The benthic community found in these sandy sediments is diverse, and typical of the communities found at such depths in sandy sediments in the North Sea.

The WTGs, the subsea umbilical linking them, and the subsea umbilical linking WTG 1 to the Beatrice Alpha platform, will all be installed on an area of seabed that is not affected by any contaminants that may be present in the historic cuttings pile located beneath Beatrice AD. The concentrations of metals and hydrocarbons in sediments around the Demonstrator site are all low, and typical of the “background” concentrations found in unpolluted sediments in the North Sea (Section 4.3.3). The sediments that may be disturbed by the operations to install the facilities, therefore, comprise clean, unpolluted material.

Long-term covering of the seabed

The base of each WTG unit will enclose an area of seabed of about 900m^2, although the area of seabed actually covered by the legs and lowest horizontal members of the support structure will be much smaller than this. Mattresses placed around the ends of the subsea umbilicals, over the pipeline crossing, and around the bases of the substructures, would cover an additional area of about 886m^2 of seabed. In total, it is estimated that the area of seabed physically covered by the WTGs would be about 2,686m^2, (Table 8.1) i.e. about 0.005% of the area of the existing Beatrice determination boundary (Figure 2.2).

Table 8.1 Summary of area of seabed permanently covered by presence of two WTGs

Components	**Area covered (m^2)**
Area of seabed enclosed by bases of two WTGs (2 x 900m^2)	1,800
Amount actually covered by mud mats (2 x 92m^2)	184
Mattresses at Beatrice AP en route to WTG 1 (23 mattresses)	486
Mattresses at WTG 1 (8 mattresses)	144
Mattresses at WTG 2 (4 mattresses)	72
Total area of seabed physically covered	**2,686**

Disturbance of the seabed

The subsea umbilicals linking the WTG units, and the units with Beatrice AP, would be installed using a high pressure water jet to fluidise the sediments (Section 3.3.3). This method does not rely on the physical excavation or displacement of sediment. An example of the type of equipment that might be used is shown Figure 8.1. The ROV trenching vehicle runs over the seabed on tracks that are about 4.5m apart, but the actual area of seabed that is fluidised is about 0.5m.

Figure 8.1 Example of the type and size of machine that would be used to fluidise the seabed for the burial of the umbilicals.

The equipment can be deployed with precision, but it is likely that a narrow strip of seabed, centred on the final route of the umbilicals, will be disturbed. Although the fluidising technique does not deliberately discharge substantial amounts of sediment into the water column, small amounts of fine-grained material will inevitably be suspended and will, therefore, drift away from the site and resettle, potentially smothering benthic communities located at a distance from the umbilical routes.

For the purpose of estimating potential impacts to the benthos, it has been assumed that all of the seabed area within the width of the ROV trenching vehicle's tracks (5m) will be disturbed. In these circumstances, it is estimated that the burial of the two subsea umbilicals would disturb a total area of about 10,500m^2 of seabed sediment. This would represent about 0.02% of the seabed within the Beatrice field determination boundary.

The sediment is clean, and although a very small proportion of the benthic community within the bounds of the Beatrice site licence may be killed, the sediment will be quickly recolonised by animals from adjacent undisturbed sediment.

8.1.3 MITIGATION PROPOSED

The installation operations for the support structure, mattresses and subsea umbilicals will be carefully planned and executed so as to minimise the area of seabed disturbed. The routes of subsea umbilicals will be designed so as to minimise the length of each umbilical, and hence the extent of seabed disturbance.

8.1.4 SURVEY AND MONITORING OF OPERATIONAL WIND FARM

There are no plans to monitor the condition of the seabed around the WTGs, although the bases of the support structures may be surveyed from time to time, using an ROV, to determine if any seabed scour is occurring. The umbilical routes may be surveyed periodically, to ensure that the umbilicals remain buried to the required depth.

However, data gathered by Talisman during surveys of the Beatrice Alpha platform and pipelines indicate there has been no significant movement of sediments that would be classed as scour. Since Talisman became operators of Beatrice in 1997, no remedial works have been required as a result of scour around jacket or pipelines.

8.2 EFFECTS OF ELECTROMAGNETIC FIELDS

8.2.1 INTRODUCTION

Several marine species use magnetic and electrical fields for navigation and for locating prey. This section provides a brief review of the literature, an overview of the electromagnetic fields typically generated by power transmission cables, and an assessment of the potential for the subsea electric umbilicals for the proposed Demonstrator Project to cause adverse effects in marine organisms.

8.2.2 ELECTROMAGNETIC FIELDS

Electrical and magnetic fields are both generated by the movement of electrical charge. Electrical fields (E fields) are proportional to the voltage (V) in a cable, and magnetic fields (B fields) are proportional to the current (A). The motion of an organism, or even seawater, through an existing B field causes the generation of an electrical field known as an induced electrical field (iE field) (electromagnetic field abbreviations after Gill *et al.*, 2005).

E fields are produced around electrical cables that are not perfectly shielded. Industry-standard cables are constructed with shielding designed to retain E fields within the cabling. B fields, however, exist beyond even industry-standard cables and, as described above, are able to induce electrical fields in the surrounding environment. Therefore, although E fields generated directly by the movement of charge in the conductor will be contained within the cable, iE fields will still exist due to the effect of the B fields generated by the current in the conductor. It is important, therefore, to consider the effects of both magnetic and electrical fields on the environment surrounding the cable.

In a typical industry-standard cable conducting 132kV and an AC current of 350A, the size of the B field produced would be 1.6μT (micro Tesla)(CMACS, 2003). This B field would be present only directly adjacent to the cable, and although it would be additive with the earth's natural geomagnetic field (approximately 50μT), it was shown that the magnitude of B field associated with the cable would fall to background levels within 20m of the cable. Furthermore, the modelling conducted by CMACS showed that the magnitude of a B field is not affected by any non-magnetic sediment in which a cable may be buried.

In the same study CMACS showed that for a cable buried 1m below the seabed the magnitude of the iE field at the seabed would be approximately 91µV/m. Although the magnitude of the B field was not affected by the fact that the cable was buried, the iE field dissipated more quickly in sediment than in seawater. At a distance of approximately 8m from the cable the iE field in the sediment was only 1 or 2µV/m, whereas in seawater the iE field at this distance was still approximately 10µV/m.

8.2.3 EFFECTS OF ELECTROMAGNETIC FIELDS ARISING FROM THE DEMONSTRATOR PROJECT

Magnitude of fields

The cable that will be used for the proposed Demonstrator Project is an industry-standard, three-phase 33kV, 175A, 50Hz alternating current (AC) XLPE (cross linked polyethylene) cable carrying 10MW. Extrapolating from studies carried out by CMACS (2003), it is predicted that this cable will generate a B field of approximately 0.8µT (halving the current has a proportional effect on the magnitude of the B field). The Beatrice cable will be buried 0.9m below the seabed, so the iE field at the seabed should be approximately 45µV/m adjacent to the cable. As the current flowing in the cable at the Beatrice Demonstrator Project will be half that modelled by CMACS (2003), it is expected that the magnitude of the B field and iE field will be approaching zero at 10m and 20m, respectively.

Potential effects of fields from Demonstrator Project

There is little information regarding the effects of interactions between sensitive marine species and anthropogenic electromagnetic fields arising as a result of offshore wind farm developments (Gill *et al.*, 2005). Studies of the effects of anthropogenic E and B fields from other types of development or activity may give indications of likely effects.

Gill *et al*. (2005) list the known electrically sensitive species occurring in UK coastal waters. The elasmobranchs (the sharks and rays) are known to possess electro-receptors, and four common species of bony fish (European eel, cod, plaice and Atlantic salmon) have all been shown to be electrically receptive, but few species have been studied in detail. For the lesser spotted dogfish *(Scyliorhinus canicula),* an E field of 1000µV/m elicits a (variable) avoidance response, whereas an E field of 10µV/m elicits an attraction response (Gill and Taylor, 2002).

The strength of the iE field in the vicinity of the cable at the Demonstrator site is likely to be below 45µV/m. Therefore, although it is likely that marine organisms will be able to detect iE fields generated by the electrical cable running between the WTGs, and from WTG 1 to the Beatrice Alpha platform, it is not possible to predict with any certainty the effect that such an electromagnetic field will have.

Previous studies have shown that marine species make use of geomagnetic fields for navigation (Walker *et al*., 1992, Dittman & Quinn 1996, Kenney *et al.,* 2001). However, little work has been done on determining the effect of artificial B fields on species that are known to use geomagnetic fields.

Souza *et al*. (1988) showed that freshwater eels *(Anguilla rostrata)* displayed a preference for travel in a different direction when an artificial B field was applied, compared to that observed under the influence of the earth's geomagnetic field alone. Walker *et al.* (1992) were able to correlate the location of whales in different seasons with areas of low geomagnetic intensity, and they concluded that this supported the existing hypothesis that fin whales possess a magnetic sense. A study of the orientation of plaice *(Pleuronectes platessa)* in the southern North Sea by Metcalfe *et al.* (1993) showed that plaice were able to orient themselves in the absence of visual and tactile clues, and it was suggested that the orientation mechanism may involve the earth's geomagnetic field.

A species of particular importance in the Moray Firth, both commercially and ecologically, is the Atlantic salmon *(Salmo salar)*. Several studies, including those by Quinn and Brannon (1982), Taylor (1986), and Chew and Brown (1989) on several different members of the Salmonid family of fishes suggest that Salmonid fishes are able to detect and orient to artificial B fields of a similar magnitude to the earth's geomagnetic field. However, a study by Yano *et al.* (1997) suggests that horizontal and vertical movement of migrating chum salmon *(Oncorhynchus keta)* in an artificial B field (of two orders of magnitude greater than the earth's geomagnetic field) was no different to their normal range of movements in the absence of the artificial B field.

Caution should be exercised when extrapolating the results of such studies to the proposed wind farm Demonstrator Project. These studies are usually carried out under controlled, laboratory conditions (with the exception of Yano *et al.'s* 1997 study), that are not representative of those that pertain in the natural world. In addition, knowing that an organism has the ability to detect B fields does not enable accurate prediction as to the effects of B fields on that organism's behaviour or physiology.

Patterns of migration indicated by tagging studies around the Scottish coast (Dunkley, 1985) suggest that Atlantic salmon make landfalls at many different parts of the coast and then redistribute themselves. Other studies such as those by Smith *et al.* (1995) and Dittman and Quinn (1996) highlight the importance of environmental factors such as salinity and temperature, as well as the olfactory sense of salmon, in the return of migrating salmon to their native rivers. The degree to which salmon rely on E and B fields compared to degree to which they rely on such olfactory and physical stimuli is not yet known.

Several other major wind farm developments have been planned, or indeed are under construction, in the UK. From a review of the environmental statements produced for these developments, it would appear that there is a general consensus that the electromagnetic fields likely to be present around a wind farm development will not have a significant environmental impact.

8.2.4 POTENTIAL MITIGATION MEASURES

There are no specific additional mitigation measures that will be taken by the project. The electrical cables are one component of the umbilical, and they are sheathed and armoured. This will shield organisms from the electrical (E) field, but not from the induced electrical (iE) field arising from the magnetic (B) field.

The umbilicals will be buried, so that they do not interact with bottom-towed fishing gear, and this will also reduce the magnitude of the induced electrical fields to which marine organisms on the surface of the seabed will be exposed; iE fields do not propagate as well through sediment as through seawater. Burial will also mean that demersal species of fish will not come into such intimate contact with the umbilicals, and thus will be exposed to iE fields of a lower magnitude.

8.2.5 CONCLUSION

It is likely that the B and iE fields produced by the subsea electrical cables for the Demonstrator Project will be large enough to be detected by receptive marine organisms. Because the cables will be buried, marine organisms on the surface of the seabed will be exposed to lower fields than they would be if the cables were exposed. It is not possible, however, to make any accurate predictions as to how these relatively weak B and iE fields will affect these species. Given the localised scale over which these electromagnetic fields are likely to propagate, however, it is likely that any effects which may occur would be highly localised. It is expected that the magnitude of the B field and iE field will be approaching zero at 10m and 20m, respectively, from the cable.

8.3 EFFECTS ON COMMERCIAL STOCKS OF FISH AND SHELLFISH

8.3.1 DESCRIPTION OF IMPACTS AND MAGNITUDE OF EFFECTS

The operations to install the WTGs and umbilicals, and the presence of the WTGs throughout their operating life, could have effects on commercial fisheries resources in the area. The potential sources of effects on fish and shellfish, which could be both short-term (installation phase effects) and long-term (duration of wind farm life), are as follows:

- *disturbance and redistribution of sediments during installation of WTGs and umbilicals*
- *scouring of sediments around bases of support structures, mattresses and pipeline crossing*
- *re-suspension of pollutants*
- *accidental release of chemicals or hydrocarbons during installation*
- *physical presence of structures in the water column*
- *loss of food resources for faunal groups.*

Disturbance and redistribution of sediment

Fish and shellfish may be affected by increased burdens of suspended sediment in the water column. This may cause, for example, increased egg or larval mortality, loss of prey species, lethal and non-lethal effects due to clogging of gills, and reduction in feeding due to decreased visibility.

Disturbance to commercially important fish and shellfish species as a consequence of sediment disturbance would potentially impact; for example, spawning grounds of herring, sprat and sandeels, all of which lay their eggs in or on the substrate; and beds of cockles, clams, oysters and mussels. It could also potentially interfere with the burrowing behaviour of sandeels, normal activities of the flatfish species (such as sole and plaice), and also the benthic feeding activities of demersal species (such as cod, whiting and haddock).

The only activity that is likely to disturb seabed sediment is the operation to bury the umbilicals by fluidising the seabed (Section 3.3.3). This may cause some sediment to be resuspended into the water column, and then settle at some distance away. Using conservative assumptions, however, it is estimated that the area of seabed that is likely to be disturbed in this way will be very small.

Given the uniform nature of the seabed throughout the area of the Demonstrator site, and the very precise nature of the fluidising technique using the ROV trenching vehicle, it is concluded that the potential effects on fish and shellfish from this source will be small.

Scouring of sediments

There is no evidence of scouring around the existing Beatrice platforms or pipelines (Section 8.1.4), and it is thought unlikely that scouring will occur around the bases of the WTGs. Scouring is, therefore, unlikely to occur as a result of the presence of the WTGs or umbilicals and will not be a source of impact to stocks of commercial fish and shellfish.

Re-suspension of pollutants

The 2005 benthic survey at the Demonstrator site (Section 4.3.3), concluded that the sediments at all stations at the site were uncontaminated, exhibiting concentrations of metals and hydrocarbons that were low and consistent with “background” concentrations for sandy sediments in the North Sea. The re-suspension of pollutants will, therefore, not occur as a result of the installation or operation of the WTGs at the Demonstrator site.

Accidental release of chemicals or hydrocarbons during installation

During installation activities, the vessels will carry bunker fuel, and the WTG nacelles will contain hydraulic fluid (Section 3.3.14), and there is a very low risk that these might be accidentally released to the sea. For the offshore oil and gas industry, the incidence of vessel collisions is very low (HSE, 2003). It is, therefore, very unlikely that such an accident would occur. Activities at the Demonstrator site would be covered by the existing Beatrice field oil spill plan, and there are resources at Beatrice to deal with a Tier 1 oil spill. Any chemicals or oils released to the sea surface would be rapidly dispersed and diluted by the prevailing conditions offshore, and so potential effects on pelagic and benthic species of fish and shellfish would be very small.

Physical presence of WTGs

The area of seabed that will be covered by the WTGs is very small (Section 8.1.2), and will have no significant impact on the standing stocks of shellfish or demersal fish.

The support structures will provide a very small additional area of hard surface that will be colonised by sessile marine organisms (fouling) (Forteath *et al.,* 1982). This in turn will provide habitat for crustacean, and will create a *de facto* artificial reef community based on the steel support structures. Diverse and mature fouling communities already exist on the nearby Beatrice platforms (Forteath *et al.,* 1983). Various species of pelagic and demersal fish are found around offshore oil and gas platforms, and it is likely that the WTGs will also exhibit locally increased numbers of species such as saithe, cod and ling. No detrimental effects on fish have been found for working offshore oil and gas platforms, and it is unlikely that the WTGs would be a source of negative effects. The “reef” effect of the WTGs is likely to provide a small positive effect, although one which would not be significant in terms of commercial stocks.

Changes to food resource

The area of seabed that will be covered by the WTGs is very small (Section 8.1.2), and will have no significant impact on the standing stocks of shellfish or demersal fish. Once installation is complete, any areas of clean sediment that were disturbed will be quickly recolonised by fauna typical of the area. It is, therefore, very unlikely that the operations to install the WTGs, and their operations at the site, will result in a noticeable decrease in the range or quantity of food resources available to fish and shellfish in the area.

8.3.2 MITIGATION PROPOSED

The potential effects on fish and shellfish stocks will be very small and localised. The majority of potential negative effects would arise only during the installation phase in summer. This avoids the spawning periods for installation activities during the period between December and April when a number of species, namely plaice, cod, lemon sole and sandeels, spawn locally during this period.

In view of the very low risk of negative effects to stocks of fish and shellfish, Talisman does not believe that additional mitigation measures are required.