NON-TECHNICAL SUMMARY

1 AIM AND PROPOSED ACTIVITY

Eldepasco has taken the initiative to build an offshore wind farm in the North Sea, to be located on the Bank With no Name. The completion of this wind farm will help to achieve the objective of the authorities regarding renewable energy (6 % by 2010; current proposal 13% by 2020). Before construction can begin, a licence must be applied for. To assist with the decision-making process concerning the licence application, the procedure for an environmental impact report together with an environmental impact assessment will be followed.

In order for the environmental interests to be taken fully into account in the licence granting, an environmental impact report (EIR) must be drawn up. This EIR will be used to underpin the consents process and must describe the construction, exploitation, dismantling as well as the cable installation.

In this EIR the environmental impact of a 3 MW and a 6 MW turbine will be discussed throughout the chapters. The 3 MW (Vestas V90) and the 6 MW (REpower 6M) will be used as type-examples for the description of respectively a "small" and a "large" turbine, to be able to cover in this way the total power range of 3 – 7 MW. If relevant, the additional effects of a 7 MW wind farm will be explicitly discussed, in case these effects differ from the effects of the 6 MW wind farm.

Finally, the cumulative impact of three current wind farm projects in the Belgian North Sea will be discussed.

2 PROJECT DESCRIPTION

The wind farm will be built on a sand bank, called the "Bank With no Name", located at ca. 38 km from the Belgian coast (Figure 1). On 15 of May 2006 Eldepasco has granted a domain concession for an area of approximately 9 km². On 29 of August Eldepasco has applied for a change and extension of the concession area to a total area of approximately 14.5 km². This EIR deals with the project in the original concession area generating approx. 144 MW (with 24 – 48 turbines) as well as with the extended project (with 36 – 72 turbines) with a total installed capacity of approx. 216 MW; the individual capacity of the turbines will vary between 3 to 7 MW.

The wind farm will yearly generate 450 (original concession) to 670 GWh (enlarged concession). This equals approx. 0.5 – 0.7 % of the yearly Belgian electricity production or approx. 4.8 - 7.2 % of the Belgian objective concerning renewable energy (13 % by 2020). This capacity could supply approx. 120,000 – 180,000 households with electricity. The power will be transported to the coast (Zeebrugge) by an underground cable.

The necessary controls regarding security and operation of the wind farm will be put in place, as well as illumination, marking and signposting. It will take 2 years to build the farm and its life expectancy will be 20 years minimum.

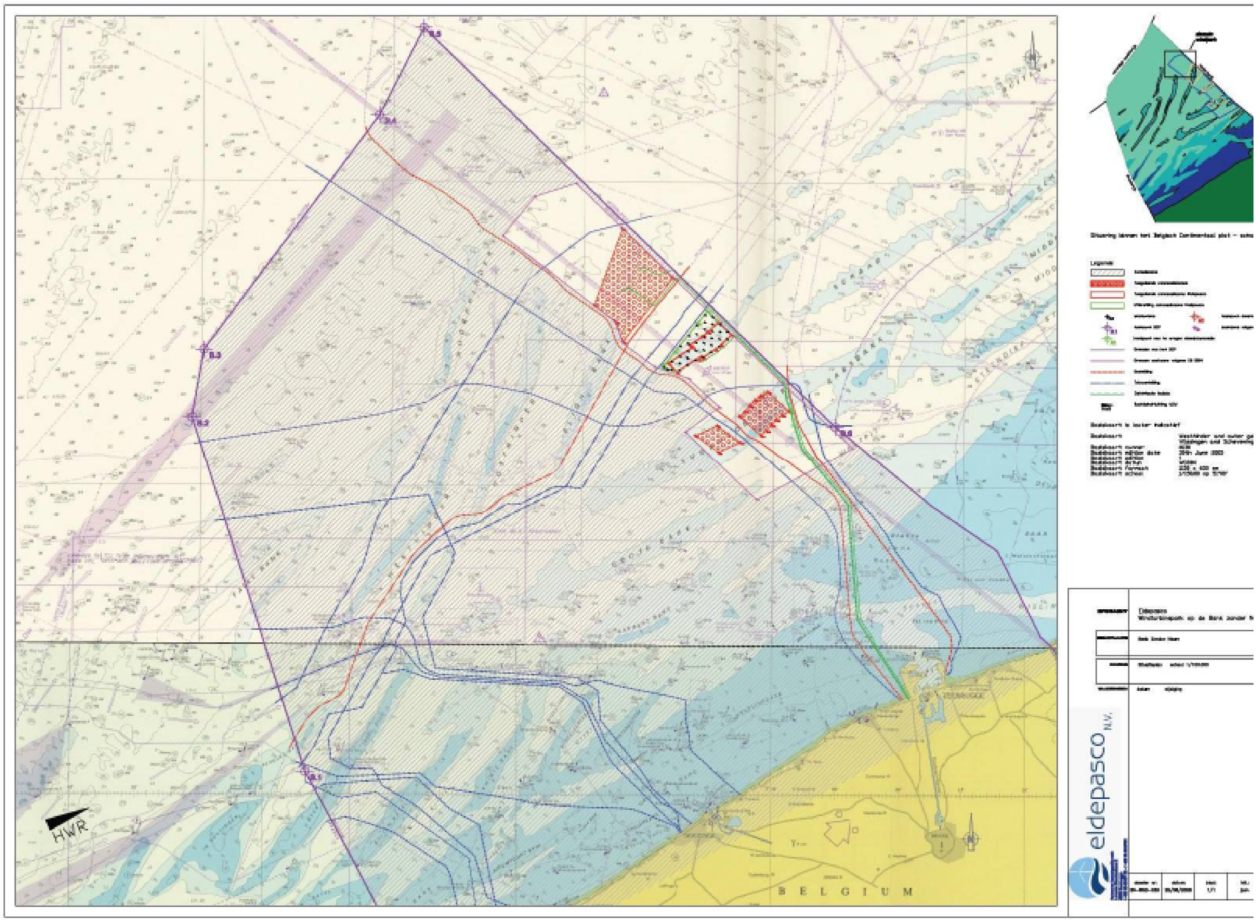

Figure 1: Location of Eldepasco project

In the table below the principal technical features of the future wind farm on the Bank With no Name are described.

Subject	*Original concession*	*Enlarged concession*
Wind farm		
Site	Bank With no Name; outside the 12 mile zone; at 38 km	Extension of the original concession in northern direction from the Bank With no Name till 250 m of the telecommunication cable SEA-ME-WE3
Installed power	ca. 144 MW	ca. 216 MW
Estimated production capacity	450 GWh/year	670 GWh/year
Number of turbines	48 * 3 MW or 24 * 6 MW	72 * 3 MW or 36 * 6 MW
Wind farm area (excl. safety zone)	Approx. 9 km²	Approx. 14,5 km²
Wind farm area (incl. safety zone 500 m)	Approx. 17,5 km²	Approx. 23,7 km²
Depth of water	Max. till approx. 24 m (MLLWS)	Max. till approx. 32 m (MLLWS)
Life expectancy	20 year	20 year
Park configuration	Configuration (see figure)	Configuration (see figure)
Construction phases (2 years)	2011: x turbines + TFP+ cables	2011: x turbines + TFP+ cables

	(sea, wind farm)	(sea, wind farm)
	2012: y turbines + cables (wind farm)	2012: y turbines + cables (wind farm)
Wind turbines		
Configuration	See figures	See figures
Capacity	3-7 MW per turbine	3-7 MW per turbine
Hub height	Approx. 70-120 meter above MLLWS	Approx. 70-120 meter above MLLWS
Rotor diameter	90 – 140 meter	90 – 140 meter
Marking/ illumination	Conform IALA directives	Conform IALA directives
Foundation wind turbines		
Either monopile	Thick steel piles are driven approx. 40 m into the seabed (probably used for 3 – 4 MW turbines).	Thick steel piles are driven approx. 40 m into the seabed (probably used for 3 – 4 MW turbines).
Either multipod/jacketstructure	≥ 3 (usually 4) thick steel piles are driven approx. 40 m into the seabed. On top a jacket structure in steel is placed (probably used for ≥ 5 MW turbines).	≥ 3 (usually 4) thick steel piles are driven approx. 40 m into the seabed. On top a jacket structure in steel is placed (probably used for ≥ 5 MW turbines).
Either gravity foundation	The foundation made of reinforced concrete is prefabricated on land and sunk into the seabed that has been levelled out previously from a vessel or pontoon (probably used for ≥ 5 MW turbines).	The foundation made of reinforced concrete is prefabricated on land and sunk into the seabed that has been levelled out previously from a vessel or pontoon (probably used for ≥ 5 MW turbines).
For all types of foundation	Erosion protection is always installed around the foundation.	Erosion protection is always installed around the foundation.
Foundation meteo mast and transformer station	Cfr. above	Cfr. above
Cables		
Cables within the wind farm site	Power cables: 33 kV + datacables Cable length: approx. 30 km Cable traject: see figures Installation depth cables: approx. 1m in seabed	Power cables: 33 kV + datacables Cable length: approx. 45 km Cable traject: see figures Installation depth cables: approx. 1m in seabed
Cables to shore	Power cables: 150 kV + datacables Cable length off-shore: approx. 42,8 km (Zeebrugge)	Power cables: 150 kV + datacables Cable length off-shore: approx. 42,8 km (Zeebrugge)

	Cable length on-shore: approx. 2,1 km until post L. Blondeellaan Cable traject: see figures Installation depth cables: approx. 2 m in seabed; 1-2 m on shore (except if obstacles are encountered)	Cable length on-shore: approx. 2,1 km until post L. Blondeellaan Cable traject: see figures Installation depth cables: approx. 2 m in seabed; 1-2 m on shore (except if obstacles are encountered)
Safety distances	Distances to respect to Interconnector/Zeepipe-gaspipeline (500 m) and telecom cables (250 m);	Distances to respect to Interconnector/Zeepipe-gaspipeline (500 m) and telecom cables (250 m);

3 ALTERNATIVES

The current EIR deals both with a change and an extension of the existing domain concession, defined as follows:

- A change of the existing concession on the Bank With no Name (= original concession area) resulting in a reduction of the total capacity to 144 MW compared to the granted concession (15/05/2006) and where depending on the turbine capacity, is chosen for 48 (3 MW) or 24 (6 MW) turbines.
- An extension of the existing concession in northern direction (= enlarged concession area) resulting in a total capacity of 216 MW identical to the granted concession (15/05/2006) and where depending on the turbine capacity, is chosen for 72 (3 MW) or 36 (6 MW) turbines.

The "change" and "extension" of the original concession, as well as the alternatives of capacity and foundation should in fact be seen as possible scenarios in stead of alternatives, where it is not the intention to weigh the alternatives on their environmental impacts.

TO LOCATION

Strictly taken, there are no alternatives for location for the licence application, but the following two scenarios can be distinguished:

- Original concession, entirely situated on the Bank With no Name. A concession was received on the 15th of May 2006 for the construction and exploitation of a wind farm on the Bank With no Name. The selection of the concession area for the Eldepasco project within the wind zone defined by the Royal Decree RD of 17/05/2004 has been based on both economical, qualitative as criteria formulated by the MUMM (Management Unit of the North Sea Mathematical Models).
- Enlarged concession. The extension of the original concession area is situated in northern direction to take optimal use of the "lost space" between the original domain concession and the northerly situated telecommunication cable SEA-ME-WE3 (respecting the safety distance of 250 m). The selection of the enlarged concession has been based on the former mentioned criteria. Besides it used to be the only possible option to make optimal use of the available space and hereby considering the known licence applications at this moment.

TO CONFIGURATION

Based on the shape of the original and the enlarged concession area and the different types of wind turbines, different alternative configurations are possible. The chosen configurations are based on an individual capacity of 3 – 7 MW where the 3 MW and the 6 MW turbines will be used as type-examples as they are or will be actually used in different offshore projects in West-Europe. Depending on the individual capacity of the turbines, the following configuration alternatives can be distinguished:

- Original concession: 24 wind turbines of 6 MW or 48 wind turbines of 3 MW; total installed capacity of 144 MW;
- Enlarged concession: 36 wind turbines of 6 MW or 72 wind turbines of 3 MW; total installed capacity of 216 MW.

For the configuration attention has been given to the minimal distances to be respected towards cables, pipelines and installations in that area.

TO CABLE ROUTE BETWEEN WIND FARM AND LAND

At this moment there are two landfall points where offshore energy can be brought on land, the substation Oostend-Slijkens and the one in Zeebrugge. Based on data from ELIA the option with landfall in Zeebrugge has been selected. Eldepasco shall - if possible and permitted- follow the cable route of other offshore wind farms (optimal use of space) and this as well at sea and on shore.

TO WIND TURBINE TYPE AND FOUNDATION TYPE

Wind turbine type

There are different offshore wind turbine types on the market with different power capacity. The capacity of the turbine will partly determine the energy production of the wind farm. The best available technology at this moment is on the one hand the 3 MW turbine of Vestas (Vestas V90) and on the other hand the 5 MW turbine of REpower (REpower 5 M). The REpower 6M goes at this moment in production (rotor diameter and hub height stay the same; due to a limited increase of the rotational speed and an adaptation of the generator a capacity of 6 MW will be reached). In between a number of alternatives like the Siemens 3.6 MW, the GE 3.6 MW, the Multibrid 5 MW,…

In view of the rapid technological evolution in the last decade, Eldepasco expects that at the moment of construction (2011-2012) sufficient appropriate turbines within the range of 3 to 7 MW will already be commercially available.

In conclusion, for the configuration of the wind farm Eldepasco the total capacity range of 3 to 7 MW will be taken into account. The Vestas V90 (3 MW) and the 6M REpower (6 MW) will be used as type-examples in the EIR.

In the Environmental Impact Report (EIR) the 3 MW and the 6 MW turbine will be discussed as type examples for respectively "small" and "large" turbines. To anticipate optimally to future developments, a best estimation will be done for the relevant parameters (rotor diameter, hub height) when upgrading to a 7 MW turbine. In case these have relevant consequences for the environment, these maximal ranges will be taken into account when describing the environmental impacts.

In the table below the characteristics of both variants are presented.

	Type example	Capacity	Max. rotor diameter (m)	Hub height (m) to MLWS
Small turbine	Vestas V90	3 MW	90	70 – 90
Large turbine	REpower 6M	6 MW	126	90 – 110
	(7 MW turbine)	7 MW	140	120

The characteristics of turbines with a capacity in between 3 to 7 MW, will be situated in between the above mentioned values.

Foundation

Various types of foundations are considered:

- Monopole: each turbine is based on one thick steel pile, driven approx. 40 m into the seabed.
- Multipod/ jacket structure: ≥ 3 (usually 4) thick steel piles are driven approx. 40 m into the seabed; on top a jacket structure in steel is placed.
- Gravity foundation: The foundation made of reinforced concrete is prefabricated on land and sunk into the seabed; the stability of the foundation type is guaranteed by the weight of the construction.

The characteristics of the different foundation alternatives are given in the table below:

	Monopile	*Multipode/jacket*	*Gravity*
Construction	1 steel pile	≥ 3 pile (usually 4)	concrete
Driving depth into seabed	40 m	40 m	Not relevant
Pile diameter	4,5 (V90) – 7 (6M) m	2 – 3 m	
Pile length	80 m	50 m	
Foundation bed	Not relevant	Not relevant	60 m diameter 0,5 m thick
Corrosion protection	Synthetic layer or paint + cathodic protection	Synthetic layer or paint + cathodic protection	Not relevant
Erosion protection: Diameter Layer M³/foundation	 30 m 1.6 m (to surface) 1,200 m³	 30 m 1.6 m (to surface) 1,200 m³	 100 m 1.6 m (to surface) 12,000 m³
Sand residue/turbine	Not relevant	Not relevant	45,000 m³

4 IMPACT ASSESSMENT

In this paragraph the most important results of the impact assessment are summarised per discipline.

Given the difficulties to quantitatively describe certain effects, a semi-quantitative approach has been chosen. The effects are described as a relation between their size, their range (dimension) and their temporarily or permanent character. The described effects are presented as a plus-minus assessment. The following definitions have been applied:

Symbol	Definition	Description	Assessment environment/ organisms
++	Significant positive effect	Measurable positive effect, large range (BPNS), temporarily or permanent character	Very positive
+	Moderate positive effect	Measurable positive effect, limited range (project area), temporarily or permanent character	Positive
0/+	Small positive effect	Measurable small positive effect, limited range (project area), always temporarily character	Neutral

0	(almost) no effect	Non-measurable effect or not relevant	No
0/-	Small negative effect	Measurable small negative effect, limited range (project area), always temporarily character	Negligible
-	Moderate negative effect	Measurable negative effect, limited range (project area), temporarily or permanent character	Acceptable
--	Significant negative effect	Measurable negative effect, large range (BPNS), temporarily or permanent character	Not acceptable

In the impact assessment a distinction has been made between effects during construction, exploitation, dismantling and the laying of cables. The possible mitigating (effect reducing) measures have also been indicated. Attention has been given to both the negative and possible positive environmental effects.

In general, the effects are comparable for the original and the enlarged concession area. If relevant a clear distinction will be given for the two scenarios for the different disciplines.

4.1 SOIL

4.1.1 Reference situation and autonomous development

The Bank With no Name (BWN) is located at approx. 38 km from the Belgian coastline, at the border with the Dutch territorial waters. The BWN is situated between the Thorntonbank and the Bligh Bank. The project area, which is partly situated north of the sand bank, has bathymetrical values between 18 and 32 m (to MLWS).

The tidal banks – including the BWN – are the largest offshore relief features. The Flemish banks seem to be very stable. The Bank With no Name lays approximately parallel with the Thorntonbank. Sand waves (some meters high) are remarkably smaller than sand banks, but are more dynamic than the sand banks prominent present at the BPNS. Recent bathymetrical surveys by Eldepasco show an average height of dunes of 4 m.

Knowledge gaps still exist about the sand dynamics, also for the area around the Bank With no Name. The sediment transport possibly results in a limited deposition over almost the entire bank. The sediment transport around the sand bank is probably counter-clockwise oriented (as on the Thorntonbank, on the Bligh bank the transport is clockwise oriented). In the gully south of the bank the transport is in the direction of the flood stream and oriented to the northeast.

The Bank With no Name is situated on top of the tertiary geological layer "Formatie of Maldegem". The Formatie of Maldegem consists of marine sediments, deposed between 20 and 50 m depth, and mainly contains rigid clay and clay-containing sand layers. The upper part of the sand banks is a quaternary sandy layer, with a maximum thickness of 20 m.

The major part of the Bank With no Name on the Belgian Part of the North Sea (BPNS) consists of moderate to coarse sand with an average diameter larger than 250 µm. North of the bank a limited zone with finer material can be found: 125- 250 µm. There should be present at most 1 % silt/clay fraction (< 63 µm). Moderate to coarse sand is mainly found north of the bank, towards the Bligh Bank. In the gully between the Bank With no Name and the Bligh Bank is a wide strip of gravel (fraction > 2 mm).

On the Bank With no Name, no samples and analyses have been carried out, but because of its close location, its comparable granulometric composition and its situation in the same tidal pattern as the

Thorntonbank, a comparable chemical environmental quality can be expected. On the basis of data available for the Thorntonbank, it can be concluded that for none of the measurable heavy metals the limiting values will be exceeded.

As a consequence of the climate change, the characteristics of the currents and the morphology of the BPNS will change too. Even within the period of exploitation some changes will already be noticeable. In addition to changes in the general average values of e.g. the sea level, temperature, etc., the number of extreme climate events is expected to increase. There are no other marine activities (wind farms on other banks, sand extraction, transport, dumping of dredging mud, …) on the BPNS which in the future could affect the Bank With no Name and the wind farm to be built there.

4.1.2 Impact description and assessment

CONSTRUCTION PHASE

When using a monopile or multipod/jacket foundation no sand is removed but the pile is simply sunk into the ground. The only effect is that the geological layers up to a depth of around 40 m in close proximity to the pile will be compacted (compressed).

In the case of the gravity foundation, per wind turbine approx. 65,000 m³ sand will be excavated, of which about 20,000 m³ will be used again to fill in the foundation pit and the gravity foundation. It is proposed that the sand left over will be:

- laid up within the concession area (total storage of approx. 1,080,000 m³ to 1,620,000 m³ of sand for respectively the original and the enlarged concession area) or
- commercially exploited; in this case the impact on the morphology will be extremely low.

The surplus sand must be stored in a location that ensures that the general morphodynamics of the area are changed as little as possible. The determination of the best location for storage of the surplus sand is not clear-cut, due to insufficient knowledge about the dynamics of the sediment. It seems best to deposit the sand in a location as close as possible to the wind turbines to be installed and to the south-west of the wind turbines. Using a layer thickness of 2 – 7 m like demanded in BMM (2007) for the Belwind wind farm seems a practical and realistic compromise. From a morphological point of view, the option to store per turbine separately must certainly be considered – in spite of taking up a relatively larger area.

The impact of the cable installation is negligible (0/-). The risk of causing significant pollution of the soil is extremely low (effect = 0).

EXPLOITATION PHASE

Although there will be a disturbance of the natural sediment transport around the wind turbines (see further on), the general natural processes on the Bank With no Name will hardly be affected (= 0). Due to the installation of erosion protection, the impact of each construction is very small and the wind turbines are very far apart. The same applies for the cables.

It is clear that if foundations without erosion protection were to be used, the local erosion would be so significant that the effect would have to be mitigated and could even jeopardize the stability of the entire construction in the long term. Therefore, the initiator will always provide erosion protection for each type of foundation. Erosion protection consists of a ring of stones around the foundation. Obviously gravity foundations, due to their larger dimensions, will require bigger erosion protections than pile foundations. The dimensions of the proposed erosion protections are sufficient for each of the foundation types considering the hypothetical dimensions of an erosion pit without protection. The erosion will in fact move to the area between the seabed and the erosion protection, in downstream direction (secondary erosion) but it will be greatly reduced. Although the erosion protection as such will be locally heterogeneous to the sandy seabed, the installation of an erosion protection is environmentally acceptable.

The cables will be laid at a sufficient depth (1 m in the park, 2 m for the cable to the shore, and even 4 m in the shipping channels) so that the chance of a cable to become exposed is relatively small. Moreover, the cable route will be monitored regularly to prevent any cables from becoming dislodged.

As is the case with the preparation phase, there is no reason at all for the exploitation to lead to pollution of the seabed (effect = 0).

DISMANTLING PHASE

The potential impact during the dismantling phase will be of the same nature and size as the potential impact during the construction phase.

The decision whether to remove the erosion protection and the cables will be made towards the end of the exploitation and will be based on the results of the monitoring, the available technology and the gained experience.

4.1.3 Mitigating measures

There should be a good timing between the construction of the foundation and the placement of the rubble. This prevents erosion and leads to a minimal use of rubble.

If the cable route must be installed over the top of other cables and/or pipes and the minimum installation depth cannot be realised, extra protection must be installed on top of the cables.

4.2 WATER

4.2.1 Reference situation and autonomous development

The currents in the North Sea waters are mainly caused by the tides (dominating component), but also by winds or differences in density (if any). The most extreme situations (strong currents and extreme water levels) arise when gale-force winds coincide with a spring tide.

In the project area the average depth of the water varies between 16 and 24 m in the original concession and can reach till 32 m in the enlarged concession. The maximal fluctuation in the depth of the water caused by wave action is about 2.5 m. Maximum wave heights are approx. 12 m. The twice-daily ebb and flood cycle off the Belgian coast causes a fluctuation in water depths that can be in excess of 5 m.

The water speeds are usually between 0.25 and 0.75 m/s. The residual average (surface) water speed is approximately 0.55 m/s. Surface currents are clearly tidal driven whereby the flood stream (from the SW) prevails over the ebb stream which comes from the NE. In the project area the currents, driven by the tides and prevailing winds, flow mainly from the SW and also from the NE - NNE.

The average water temperature in the BPNS (Belgian Part of the North Sea) is around 11 °C. There are seasonal variations of 8 or 9 °C in relation to the average temperature. The salinity in the BPNS amounts to 31-35 g/kg.

For the Bank With no Name it can be assumed that the natural concentrations of heavy metals are relatively low. The main organotin compound is tributyltin (TBT). It is a biocide that is used in the aquatic environment as an antifouling. The tributyltin concentration offshore amounts to <1 ng/l. Bunker oil and lubricating oil are the main sources of oil pollution in the North Sea. The oil spills from drilling for offshore oil and gas industries has been greatly reduced over the last 10 years (by more than 80 %). The human influence on the nutrients balance can be detected mainly in the coastal zones and not so much in the sandbank area.

The turbidity or clarity of the seawater is determined by the amount of floating particles in the water (in suspension). Specific information for the Bank With no Name has not been found, but it can be assumed that average concentrations will certainly be lower than 10 mg/l.

The climate change will bring about changes in the current characteristics and in the chemical properties of the seawater. Even within the time-span of the exploitation period, some changes will already be noticeable. For example, as a result of global warming a global sea level rise of 0.9 m maximum is expected in the period 1990-2100. In addition to changes in the general average values of e.g. sea level, temperature etc., an increase in extreme climatic events is expected.

Furthermore it is to be expected that the anthropogenic impact on the water quality in the marine environment will drop further. For instance, TBT concentrates, heavy metals, nutrients supply via rivers, etc. should show a positive downward trend in the future. There are no other marine activities (wind farms on other banks, sand extraction, transport, dumping of dredging mud, …) on the BPNS which in the future could affect the Bank With no Name and the wind farm to be built there.

4.2.2 Impact description and assessment

CONSTRUCTION PHASE

During the installation phase – of the cables as well as the wind turbines – the hydrodynamics will not be affected, irrespective of which type of foundation is used.

Analogue to heavy metals, the potential impact of the release of organic pollutants from the top layer of sediment during construction is relatively minor (0/-). Since the North Sea has been designated a 'special area' (according to MARPOL 73/78) for waste since 1991 and for oil since 1999, this activity will not result in the dumping of waste or oil as it is legally forbidden (for ships > 400 ton). Dredging may cause a minor temporary increase in nutrients in the water column. The antifouling paint used on the vessels during the installation phase is TBT-free as since 2003 a world-wide prohibition exists on the use of TBT for ships and since 1 of January 2008 all TBT should be removed from the ships. No impact is expected on temperature, dissolved oxygen or salinity.

During the construction of the foundation, the turbidity may locally increase when the piles are sunk (monopile, multipod), when dredging and when the sand is put back (gravity foundation). Usually the work will be carried out in calm weather conditions (slow current), so it can be assumed that the natural turbidity will be low. This also means that any churned-up sediment will settle relatively quickly and in a small radius around the activities. The construction of the foundation will, for each construction method and type of foundation, bring a local and temporary increase in turbidity, but the impact will be negligible in comparison with the turbidity concentrations caused naturally by high winds (0/-).

The impact (increase in turbidity) – for both types of cables and construction methods – is judged to be temporary and local (0/-).

EXPLOITATION PHASE

A wind farm construction will have no significant impact on the current, nor will the underground cables.

No long-term impact on the quality of the water is expected. The risk of an accidental discharge with an immediate impact on the water quality is judged to be extremely small.

Apart from an insignificant local turbidity in close proximity to the foundation (from disturbing the sand near the seabed) during the exploitation phase, the activity will have no effect whatsoever on the turbidity, irrespective of the type of foundation. The underground cables will not affect the turbidity.

DISMANTLING PHASE

Impacts during the dismantling phase (i.e. the removal of the piles and possibly the removal of the erosion protection and underground park and land cables) will be similar to those during the installation phase. Moreover, most of the effects will have even less impact than during the installation phase.

4.2.3 Mitigating measures

As part of the global safety and environmental management system, a clear procedure needs to be in place that describes in which way and by whom actions will be taken at the moment a calamity occurs during installation, exploitation or dismantling that can have adverse consequences for the water quality (e.g. oil spill).

4.3 CLIMATOLOGICAL FACTORS AND ATMOSPHERE

4.3.1 Reference situation and autonomous development

Belgium has a temperate sea climate, with cool summers and mild winters. The conditions at sea are similar, but there is a more constant wind climate and higher wind speeds. The prevailing wind direction near the Belgian coast is (W)SW. The wind speed increases with the height above sea level. At an altitude of 100 metres above sea level, the wind speed averages between 8.5 and 10 m/s.

As regards the global climate, for this project the greenhouse effect and global warming are especially relevant. The increase in atmospheric concentrations of CO_2, CH_4 and N_2O is by far the most important cause of global warming. In order to reduce the emission of greenhouse gases, a switch to environmental-friendly energy, such as solar energy, biomass energy, wind energy, etc. is essential.

As regards the air quality, the relevant parameters are CO, NO_x, SO_2 and PM10 (dust). The air quality off the Belgian coast more than meets the quality objectives for these parameters. CO_2 is, as stated earlier, of particular importance with respect to the greenhouse effect.

For the autonomous development it can be stated that:

- there will be no emission as a consequence of the use of materials, the construction and dismantling of the wind farm and therefore there will be no temporary impact on the local air quality;
- the prevented emissions as a result of the electricity production by the wind farm will be realised ;
- the atmospheric CO_2 concentrations will increase further;
- the Intergovernmental Panel on Climate Change expects a warming of 0.2 °C per decennium over the next 2 decennia, a value in accordance with the warming observed at the moment. The forecast for the average global warming towards 2100 strongly depends on the emission scenarios consulted. Compared with the period from 1980 to 1999 the warming is expected to be in the region of 1.8 to 4.0 °C. The expected sea level rise varies between 18 and 90 cm.

4.3.2 Impact description and assessment

4.3.2.1 Construction phase

During the construction phase, not just the actual construction of the wind farm is to be taken into account but also the winning of the raw materials needed to produce the various components of the wind turbines. This phase also involves the production of the components, the pre-assembly of the wind turbines and parts in a nearby port (in this case Zeebrugge or Ostend), transport to the Bank With no Name and the actual construction of the wind farm.

The energy consumption and related emissions will be greatest during the period of winning the raw materials up to and including the production of the turbine components.

The negative impact on the air quality will be greatest for the gravity foundations (due to the relative higher number of transports and as a consequence a higher energy use and higher emissions) and lowest for the monopole or multipod/jacket, but will remain limited (0/-) in all cases.

The additional emissions resulting from the shipping traffic will have a negligible negative impact (0/-) on the local air quality near the Channel.

4.3.2.2 Exploitation phase

During the exploitation phase there will be some energy consumption for inspection and maintenance of the wind farm.

However, the most important effects during the exploitation phase are the emissions prevented on land as a consequence of the fact that the estimated net electricity production prognosis of the wind farm namely 450 (original concession) and 670 (enlarged concession) GWh/year does not have to be generated by traditional (partly nuclear or not) production.

The emissions prevented annually, calculated on the basis of the emission factors for traditional production, amount to 1.6 % (original concession) to 2.4 % (enlarged concession) of the emissions by traditional production in Belgium for all pollutants. The emissions prevented annually, calculated on the basis of the emission factors for traditional production and nuclear production, amount to 1.0 to 1.4 % of the emissions by traditional production in Belgium for all pollutants.

Towards 2010 emission ceilings will be imposed on Belgium for SO_2 and NO_x of 99,000 and 176,000 tonnes/year respectively (2001/81/EG). The prevented emissions, calculated on the basis of the emission factors for traditional production, amount to 0.54 (original concession) to 0.80 % (enlarged concession) of the emission ceiling for SO_2 and 0.28 to 0.42 % of the emission ceiling for NO_x, which is significant. The Kyoto target for Belgium is a reduction in greenhouse gas emissions of up to 130.5 million tonnes CO_2 equivalent by 2010. The prevented emissions, calculated on the basis of the emission factors for traditional production, amount to 0.30 to 0.44 % of this ceiling, which is significant.

If the electricity production of the wind farm should effectively lead to an equivalent reduction of the electricity production on land by means of traditional thermal production, it would have a significant positive effect (++) on the air quality on land.

The wind farm will only contribute to a very limited degree towards the reduction of greenhouse gas emissions on a global scale, but it will make a measurable contribution (+) as far as Belgium is concerned. Any effects that this reduction in greenhouse gases may have, e.g. on the sea level and on the temperature of the earth, will thus be too small to assess correctly. Effects on the prevention of extreme situations (gales, severe winters, hot summers, …) are even more difficult to assess, but will be just as small.

The impact of the wind farm on the local wind climate will be restricted to some very local effects in the wind farm area. The wind climate (wind speed, turbulence,…) will be influenced by the wind farm up to more than 4 km from the last wind turbines.

The negative effect of the heat emission of the buried cables on the local temperature climate will be restricted to a small surrounding area in the seabed (no more than a few metres) (0/-).

4.3.2.3 Dismantling phase

The dismantling phase has a positive influence on the energy consumption in the lifecycle of a wind turbine because approx. 80 % of the turbine material can be used again. The winning of new raw materials and related emissions will therefore be reduced.

The impact on the air quality as a result of emissions by the vessels used for the dismantling is, just as in the construction phase, local (around the wind turbines), limited in time and insignificant compared with the emissions in total of the shipping traffic in the Channel, so that the negative impact on the air quality is small (0/-).

4.3.3 Mitigating measures

Globally wind turbines will account for a significant reduction in emissions compared with the emissions of traditional power stations on land, which has an extremely positive effect on the air quality and on the reduction of greenhouse gas emissions. Moreover, the negative impact of the project on the air quality during the construction and dismantling phase and on the wind climate and sediment around the cables during the exploitation phase is limited, so that no need for mitigating measures or compensations arises.

4.4 NOISE AND VIBRATIONS

4.4.1 Reference situation and autonomous development

For the purpose of the reference situation the existing noise climate in 4 locations is discussed, i.e. above water, underwater, at the shoreline and in the nearest housing area.

The natural underwater background noise level lies between 90 and 100 dB (re 1µPa) at frequencies ranging from 100 Hz to a few kHz. Natural noises are the main contributors. Passing ships however can temporarily increase the sound pressure level (110-120 dB (re 1 µPa)) in the same frequency range.

Above water the background noise level (LA95) is estimated to be 35 + 5 dB(A).

According to data found in literature, it seems that near the shore the background noise level lies between 50 and 65 dB(A) at 25 m from the shoreline. This sound pressure level depends on the wind direction and wind speed.

In the nearest housing area the background noise level lies between 30 and 40 dB(A).

As far as noise is concerned, no significant change is to be expected in the autonomous development of the area from a global point of view. The underwater noise will hardly evolve because no appreciable increase in shipping traffic is expected in the shallow coastal waters above this sandbank. Only the construction and the exploitation of the wind turbine parks of C-Power (Thorntonbank) and Belwind (Bligh Bank) will effect a change compared with the current situation.

4.4.2 Impact description and assessment

4.4.2.1 Construction phase

As a consequence of the activities during the construction phase (piling, shipping…) the noise level will temporarily increase, above water as well as underwater. However these negative effects are limited (0/-) till moderate (-) and are thus within the acceptable range.

4.4.2.2 Exploitation phase

Underwater

When assessing the underwater sound level it must be noted that there is a lack of knowledge about the noise immission and emission of the wind turbines used (3 MW or 6 MW).

The specific noise of a wind turbine predominantly consists of frequencies lower than 1 kHz and a sound pressure level between <90 and 115 dBLeq re 1 µPa at a distance of 1 m.

Calculations show that at a distance of 500 m (safety zone) from the wind turbine the specific sound of the wind turbine underwater will probably be masked by the background noise. When under water the maximum background sound is 195 dB (re 1 µPa) the wind turbines will only be clearly detectable up to 50 m. As a result of this conclusion it is assumed that for all underwater fauna there is a masking effect of the detection of sound that is similar to the masking effect occurring in the hearing of most land animals. At higher wind speeds the specific sound of the wind turbine will increase, but at the same time the background noise level will increase too by wave action and water movement. Finally, it can be assumed that the impact of the sound of the wind turbine underwater will at worst be restricted to the area between the wind turbines and will not go past the 500 m safety zone (moderate negative effect). It is important to point out that when a small ship passes by, noise levels are detected of more than 10 dB higher than the maximum background noise levels referred to earlier. However this rise in the noise level is temporary.

Above water

In a moderately aggravating situation sound travels three-dimensionally, and at a distance of 0.6 - 1.1 km and at a distance of 1.0 – 1.9 km reaches a sound level of 45 and 40 dB(A) respectively. Above water the wind turbines can be heard at a distance of up to 5 km. Above water, just as underwater, the specific sound of the wind turbines will increase along with the wind speed, but at the same time the background noise level will rise too.

In general it can be said that nearest to the wind farm where shipping is allowed (500 m safety zone around the wind farm) the wind turbines can be heard with a sound level of around 50 dB(A). 50 dB(A) can be compared with the noise of light traffic at 30 m, rain, a fridge, or ambient sounds in the woods.

The sound of the wind farm calculated in a moderately aggravating situation (when sound travels three-dimensionally) on the shoreline and in the nearest housing area will be lower than the measured background noise and therefore undetectable.

4.4.2.3 Dismantling phase

As a result of the activities during the dismantling phase the sound levels will temporarily increase, above water as well as underwater. However no significant negative effects are anticipated.

4.4.3 Mitigating measures

In view of the lack of knowledge and experience about the impact of the underwater sound of the wind turbines used in this project (3 MW or 6 MW) it is proposed that the underwater sound levels should be monitored.

As the number of observers at sea who would frequently notice the wind turbines is very limited indeed, it does not seem useful to propose mitigating measures for the sound in the air either. It is evident that the best available technology should be used.

4.5 FAUNA, FLORA & BIODIVERSITY

4.5.1 Reference situation and autonomous development

4.5.1.1 Invertebrates and fish

The description of the invertebrates and the fish in the study area is initially based on the recent study about the reference situation on the Thornton Bank (The Maersschalck *et al.*, 2006), considering the proximity of this sand bank (6 km). This was followed by a consultation of other recent studies that gathered data of various research projects to produce a description of the benthic communities in the Belgian part of the North Sea.

Marine organisms that live in or on the seabed, or benthos, are an important part of the food chain (dominant prey for demersal fish) and the ecosystem. They contribute to the biodiversity and the productivity of the sea. In this study we focus exclusively on the epibenthos (> 1 mm; on the seabed) and the macrobenthos (> 1 mm; in the seabed). Due to its limited mobility the presence of macrobenthos is an important indicator for the 'health' of marine systems. As regards the fish we focus only on fish living on or near the seabed (demersal fish) as they are the ones that will probably be affected most by the planned activities.

Along the onshore-offshore gradient of the Belgian Part of the North Sea (BPNS) five clearly defined communities can be found, named after the most dominant species in the community. In between, another 6 transition-communities are identified. The Bank With no Name is characterized by the *Nephtys cirrosa* community (Van Hoey *et al.*, 2004; Degraer *et al.*, 2006). This macrobenthos community is the most widespread community in the BPNS and occurs in rather fine-grained sediments. The community is characterized by a low biodiversity and density, typical of well-sorted mobile sands. Mobile polychaeta (e.g. *Nephtys cirrosa*) and crustacea (e.g. *Bathyporeia guilliamsoniana* and *Urothoe brevicornis*) are typical species in this community (Van Hoey *et al.*, 2004). The dominant species are similar to the ones found on the Thornton Bank. However, due to the richer community, higher densities and biomass values can be expected. According to the biological valuation map (Derous *et al.*, 2007) the project area on the Bank With no Name has been classified as an area of moderate to high biological and ecological value (macrobenthos). In view of its offshore location the densities and biomass values will be certainly much lower than in the rich coastal areas.

The densities of the epibenthos on the Bank With no Name are very low in comparison with the rich coastal areas.

In analogy with the findings on the Thorntonbank, expectations are that the Bank With no Name will be an important spawing area (spring) for sprat and herring, and to a lesser degree for a.o. dab and solenette. In the spring, the dominant are: sprat *Sprattus sprattus* and herring *Clupea harengus* (Clupeiformes), as well as reticulated dragonet *Callionymus reticulatus*. In the autumn, the main species were horse mackerel *Trachurus trachurus*, lesser weever *Echiichtys vipera*, both dragonets and sand goby *Pomatoschistus minutus* for the Perciformes and solenette *Buglossidium luteum* and dab *Limanda limanda* for the Pleuronectiformes. In the spring, the fish are mainly representatives of the Clupeiformes (>80 %). In the autumn however, there were hardly any Clupeiformes at all. The Bank With no Name is less important for the commercial exploitation of fish and shrimp than are the coastal areas.

As regards the autonomous development it can be said that the benthic communities and the demersal fish fauna would not really change if no wind farm were built and exploited. Long-term trends don't show any change in dominant species, just a general increase in density and diversity. On the other hand, activities such as fishing and aggregate extraction, mariculture, as well as climate change are more likely to have an impact on the underwater fauna.

4.5.1.2 Birds

The range of species on the Bank With no Name is not quite the same as in other parts of the BPNS. Coastal species are less prominent; species that are found further out at sea such as Gannets, Kittiwakes, Guillemots and Razorbills form a large part of the range of species on the Bank With no Name. The Bank With no Name is not regarded as being an area of importance for any rare seabird.

During the winter period there is a variety of species on the Bank With no Name: mainly Guillemots, Kittiwakes and Razorbills, but also (to a lesser extent) Great black-backed gulls, Herring gulls, Common gulls, Little gulls, Great skua, Gannets, Northern fulmars and Divers. In spring the Bank With no Name is often visited by Kittiwakes, Lesser black-backed gulls, and Guillemots. Northern fulmars, Herring gulls, Gannets, Little gulls, Great black-backed gulls and Sandwich terns have also been spotted during this period, but only sporadically. During the autumn, Guillemots, Kittiwakes, Northern fulmars, Gannets and Great black-backed gulls are dominant on the Bank With no Name. A small percentage of the birds on the Bank With no Name in the autumn are Razorbills, Lesser black-backed gulls, Divers, Common gulls and Great skua.

In addition to the typical seabird species a large number of non-seabirds also appear over the BPNS. Many of these species such as Cormorants, Wigeons and Mallards are in fact coastal birds. The offshore Bank With no Name is therefore not an area of importance for these non-seabirds. Bar-tailed godwits and Grey plovers can appear at the Bank With no Name. Songbirds use the Belgian sea areas as migrating routes. Only Common starlings, Chaffinches, Skylarks, Redwings and Meadow pipits have been spotted in significant numbers from ships in the North Sea. The migration is most concentrated along the shore; further out at sea the migration is more spread out.

For the autonomous development it may be stated that if no wind farm were installed on the Bank With no Name, the ornithological value of the site would remain virtually unchanged. With the exception of (semi)-natural fluctuations in the number of seabirds (e.g. by changes in food availability, or a shift in wintering areas) there are no indications that major changes are occurring in the target area at this moment. Changes in the seabird population as a result of global warming will not be measurable in the short term and therefore not interfere with future monitoring of seabirds in the target area (Stienen *et al.*, 2002).

4.5.1.3 Sea mammals

All sea mammals are protected species, where Belgium has taken the responsibility to protect and preserve them as much as possible from negative impacts. Whales and seals are species of the European

Habitat Directive (Annex II and IV), which means that they may not be disturbed during wintering, reproduction and migration (article 12). In the framework of ASCOBANS (Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas) Belgium has also accepted to strive for the avoidance of significant disturbance, especially acoustic disturbance (BMM, 2007c).

Since the spring of 2003, sea mammals are increasingly found in the BPNS, whereby Harbour porpoises and White-beaked dolphins are the main species. This is a general trend, possibly a result from the rapidly deteriorating food conditions in the more northerly areas where these species are found, although other reasons cannot be excluded (Courtens *et al.*, 2006).

Four sea mammal species, the Common seal, Grey seal, Harbour porpoise and Bottlenose dolphin, have a resident population in the North Sea: they use this area as a breeding ground and to find food. White-beaked dolphins, Atlantic white-sided dolphins and Minke whales stay regularly in large numbers in a wide area of the North Sea to feed (ICES, 2001). Based on the number of beachings on the Belgian coast and sightings in the BPNS, four species of sea mammals can be considered to appear regularly or quite regularly in the Belgian marine waters: Harbour porpoises, White-beaked dolphins, Common seals and Grey seals.

Of the four more common sea mammal species, the Harbour porpoise is the most prevalent in the Belgian marine areas. They are present all year round in the Belgian sea areas, but are more often seen in the spring (January to May). The presence of Harbour porpoises and the numbers in Belgian marine areas are fairly unpredictable. Preliminary data seems to suggest that in certain areas more Harbour porpoises are observed than in other regions. Compared to the Stroombank/ Nieuwpoortbank, Thorntonbank, Hinderbanken the number of Harbour porpoises on the Bank With no Name seems underrepresented (Depestele *et al.*, 2008). Due to the mobility of sea mammals, the migrations they undertake, and the limited number of observations further offshore, it is currently very difficult to determine migration corridors or areas that are more or less important for sea mammals (BMM, 2007c). In comparison with the total population size in the southern North Sea, Stienen *et al.* (2003) finds that the population in the BPNS is of little significance on an international level.

From the MUMM database (not published, Management Unit of the North Sea Mathematical Models) it appears that each year some groups of White-beaked dolphins are seen at sea. The analysis of a large number of data shows that the White-beaked dolphin is relatively rare in the southern North Sea compared to the central and northern parts of the North Sea (Reid *et al.*, 2003). Stienen *et al.* (2003) states that, compared with the overall size of the North Sea population, the species is not very significant for the BPNS.

In Belgium no seal colonies are found, but both Grey seals and Common seals are regularly reported in the BPNS during the last years (BMM, 2007c). Common seals are mainly seen along the coastline in autumn and during the winter months (August - February) and not so often in spring. The largest concentrations of Common seals on our coast are found on the West coast (near the Flemish Banks). The place with Common seal colonies nearest to the Bank With no Name is the Zeeuwse Delta with around 300 animals (MUMM, 2007c). The number of Grey seals in the southern North Sea is lower than the number of Common seals and negligible in proportion to the overall North Sea population.

As regards the autonomous development it can be said that if no wind farm were installed on the Bank With no Name the value of the site for marine mammals would effectively stay the same. With the exception of (semi)natural fluctuations in the number of sea mammals (e.g. by changes in food availability, or a shift in wintering areas) there is no indication that major changes are occurring in the area at this moment. Changes in the sea mammal population as a result of global warming will not be measurable in the short term and will therefore not interfere with future monitoring of sea mammals in the area (Stienen *et al.*, 2002).

4.5.2 Impact description and assessment

4.5.2.1 Invertebrates and fish

CONSTRUCTION PHASE

Potential impacts during the construction phase are: destruction of habitat (loss of biotope), loss of organisms, disturbance (sedimentation, noise and vibrations, release of materials embedded in the sediment, oil). With the exception of the destruction of the biotope and organisms, the other effects will be temporary.

The installation of the wind turbines and the transformer platform with the erosion protection will take up part of the biotope of the benthic organisms. This loss of biotope depends very much on the type of foundation and the number of turbines (~ capacity). For the monopole and multipod/jacket structure the direct biotope loss per turbine is 707 m². In the case of gravity foundation a considerable area is going to be disturbed by the storage of the sand dredged for the foundations (indirect biotope loss), next to the direct biotope loss per turbine (18,225 m²). Depending on the storage scenario, 45,000 m²/turbine (storage 1 m) or 9,000 m²/turbine (storage 5 m) will be disturbed.

In the original concession area for the monopile and multipod/jacket maximum 0.04 km² (3 MW) will be affected, while for the gravity foundation it increases to 3.22 km² (3 MW) with storage of 1 m. If storage of 5 m thick layers is chosen, the total loss of habitat decreases to 1.39 km² (3 MW).

In the enlarged concession area in total (entire wind farm) a maximum loss of 0.05 km² (3 MW) is obtained for the monopile and multipod/jacket, while for the gravity foundation it increases to 4.68 km² (3 MW) with storage of 1 m. If storage of 5 m thick layers is chosen in this last option (3 MW), the total loss of habitat decreases to 2.01 km² (3 MW).

In case a storage scenario of 5 m is chosen, this means a reduction of habitat loss of approximately 43 % for the original as well as the enlarged concession area compared to the 1 m storage. This effect will manifest itself immediately and is irreversible during the exploitation phase of the park. Despite the significant negative effect in case of 1 m storage for gravity foundation for the concession area sensu stricto, the affected area is small in proportion to the entire BPNS (max. approx. 0.1%), and therefore the biotope loss for benthic organisms is considered to be a limited (0/-) to moderate (-) negative, but acceptable effect (-) for all foundation types.

The installation of the foundations and the erosion protection will result locally in a loss of creatures that is directly proportional to the loss of biotope. Nearly all macrobenthos is found in the top 10 cm of the sediment. Part of the epibenthos and some demersal fish will also be damaged or die. It concerns a direct and irreversible effect.

In case of a monopile or multipod/jacket foundation, the negative impact is negligible (0/-), regardless of the original or enlarged concession area. In case of a gravity foundation, the loss of organisms will increase significantly for the concessions sensu stricto (-) compared to the other two foundation types, but the influence of the mortality is expected to have only a small negative (0/-) impact on the biomass or functioning of the local ecosystem (BPNS) (both for the original and the enlarged concession). Colonization by organisms of the replaced sand (storage) will moreover probably occur within a year. Despite, it is true that the potential closure of an area to certain activities (such as trawler fishing) will have a positive effect (+) on the benthos as well as fish stocks (refugium effect).

During the construction phase the entire concession area will be disturbed. This disturbance will predominantly arise from the production of noise and vibrations, churning up of the seabed and the ensuing change in turbidity. The increase in turbidity may lead to a blockage of the filter mechanisms of marine organisms with potentially fatal consequences, but it can also increase the availability of prey for the fish. Despite the degree of disturbance (sedimentation) due to the construction of the wind farm is comparable with the sand extraction activities carried out in the North Sea, the disturbance (sedimentation) caused by the installation of the offshore wind turbine park is local and temporary. Furthermore, the communities present there have already adapted to the by nature extremely dynamic system, so that the negative influence by sedimentation is expected to be moderate (-) for the gravity foundation for both the original and enlarged concession area. In case of monopile or multipod/jacket, the negative influence is expected to be minor (0/-), as the quantities of storage are significantly lower.

Most of the noise disruption will occur during piling when a monopile or multipod/jacket foundation is chosen. This disturbance may lead to significant effects (damaged hearing, bleeding, mortality, behavioural changes) on certain fish. There is however still a great deal of uncertainty about the scope of the impact and species-specific data are not available. Based on recent monitoring studies in Horns Rev and Nysted, the impact is judged to be slightly negative (0/-). Further investigation is needed.

EXPLOITATION PHASE

The most important effects resulting from the exploitation of the wind farm can be summarized as follows: introduction of hard substrate, noise and vibrations and other forms of disturbance.

The introduction of hard substrate in sea areas that almost exclusively contain sandy sediments is probably the most important effect of the installation of the wind farm. It will lead to greater heterogeneity of the habitat, and the creation of a new community typical of hard substrates. It will also increase the abundance and the biomass of certain species. Which species of fauna and flora and in what numbers they will populate the artificial structures depends on the complexity and the height of the structure, the incidence of light, the water depth and the kind of materials used. Depending on one's point of view this effect can be regarded as positive (e.g. increased biomass and diversity) or negative (e.g. disturbance of natural habitat, new "harmful" species).

The total hard substrate area very much depends on the type of foundation and the number of turbines. For the entire wind farm the volume of hard substrate that may be colonized by organisms (say: 20 m from the turbine + 1 m erosion protection) will vary between 29,921 m² (monopile/ multipod/ jacket; 6 MW) and 389,938 m² (gravity foundation; 3 MW) for the original concession area and between 42,111 m² (monopile/ multipod/ jacket; 6 MW) and 565,793 m² (gravity foundation; 3 MW) for the enlarged concession area. In absolute terms this means a higher volume than in the original concession, but relative to the concession area sensu stricto it is a smaller share namely max. 3.96 % (compared to max. 4.06 %).

The magnitude of the impact – irrespective of whether it is judged to be positive or negative – is at this moment in time difficult to estimate for the offshore wind farm in the North Sea. What is clear is that the area of hard substrate introduced is going to be considerably larger when gravity foundation and 3 MW configuration (more turbines) is used than with a monopile or multipod/ jacket foundation. The area that effectively becomes available for colonization by organisms is – regardless of the type of foundation – relatively small as the foundations as well as a large part of the erosion protection are buried in the seabed and therefore completely covered by the original soft substrate. So it may be expected that, in spite of the significant changes in relation to the original situation, the impact can be regarded as being acceptable (+ or -), considering that the area covered by these artificial structures as well as the available area for the development of a new community is relatively small in proportion to the Belgian part of the North Sea (< 0.01 %).

Underwater noise probably affects fish and mammals most. Sound plays a role in the detecting and catching of prey, communication, chasing away enemies, etc. The emissions of noise and vibrations in the marine water column can lead to a change in behaviour or a reduction in habitat size. The extent of the impact or damage and acclimatization depends also on how sensitive to noise the species of fish involved are. Quantifying the impact therefore requires species-specific data and these are not available for the area in question. Calculations in the chapter Noise show that within the safety zone (500 m) the underwater noise will probably be completely masked by the ambient background sounds. The findings of the wind farm in Denmark do not directly indicate that noise and vibrations cause a negative impact on the fish community. Since the opening of the wind farm, some new species of fish have even settled in the area, but more research is definitely needed.

In spite of the fact that it is not straightforward to make a quantitative estimate of the impact, it can be assumed that the effects of noise and vibrations during the exploitation phase are of minor consequence and that technological improvements will possibly lead to lessening the impact even more.

The shadow-effect of rotating turbine blades on fish is not known.

No negative impacts (0) are expected on the water quality or as a result of hydrodynamic changes, both for the original and the enlarged concession area.

DISMANTLING PHASE

Grosso modo comparable operations will be executed during the dismantling phase as during construction, but the order of execution will be reverse. During dismantling the same equipment will be used as during construction. Eldepasco is committed to return the site as near as is necessary to its original state if required for reasons of use, exploitation or ecological parameters.

In general the effects of the dismantling phase can expected to be more or less identical to those of the construction phase, but the intensity of the impacts will be lower. The noise disturbance will for example be limited to the noise produced by the involved ships and the dismantling activities (cutting of turbines at 2 m under seabed; removal of gravity foundation). The significant noise disturbance due to piling (monopile/ multipod/ jacket) during construction will not be present here. Also the loss of habitat and organisms will be limited to the areas actually disturbed during dismantling (so no indirect loss due to storage (gravity foundation). The effects will vary from (almost) no effect (0) to a small negative effect (0/-), depending on the number of turbines (3 MW configuration > 6 MW configuration).

CABLING

The impacts caused by the cabling are not affected by the type of foundation, output of the wind turbine or configuration, regardless the original or the enlarged concession area.

Along the entire cable route a temporarily disturbance (churning up of the seabed and sediment and altered turbidity) will occur, but is judged to be insignificant.

The transmission of electricity via sub-sea cables will generate electric and magnetic fields. These electromagnetic fields depend on the type of cable (33 kV versus 150 kV). Electromagnetic fields can affect certain sensitive species, but the size of the impact and the cause-effect relation cannot be accurately assessed on the strength of the available knowledge. More is known about the impact on rays and sharks that are likely to be affected most, but these are not commonly seen in the project area. On the basis of this fact and the fact that burying the cables at a depth of 1 m (cables in park) and 2 m (cable to shore) will have a mitigating effect (reduction directly proportional to the depth squared), we can assume for now that the impact will be almost not existing (0).

The buried cables will radiate a certain amount of heat. Because the cables are laid at depth, this will generate a minor and very local warming of the seabed surface. The effect is judged to be negligible (0/-).

4.5.2.2 Birds

The effects of a wind farm on birds are extremely variable and depend on numerous factors. Therefore the impacts of every wind farm will be different and must be assessed individually. Conducting a study of the local situation is essential in order to be able to assess the effects in the area. The description of the impacts is generally applicable for the larger study area "Bank With no Name". If relevant the effects will be discussed separately for the different configuration scenarios in the original and enlarged concession area.

Wind turbines can cause problems for birds in two ways. Firstly they can collide with parts of the turbines (mainly the rotor blades) which may kill or injure them (collision aspect). Secondly the birds may be disturbed by turbines (disturbance aspect), in the shape of loss of habitat, restriction of flyways, disturbance by the physical presence of the turbines.

CONSTRUCTION PHASE

During the construction phase a disturbance of the marine avifauna can occur as a result of the activities. Species sensitive to disturbances (such as the Red-throated diver, Common scoter, Great crested grebe, Guillemots, Razorbills) may consequently temporarily avoid the area; other species (e.g. gulls) could possibly benefit from the activities by food becoming available temporarily (churning up of the seabed, increased shipping movements).

Of the species that are sensitive to disturbance only the non-coastal Guillemots and Razorbills are found in the Bank With no Name area. If the current planning for the construction of the wind farm is adhered to (i.e. construction spread over 2 years, probably period April - October) only these two species are likely to experience disturbance, as these species are found in the Bank With no Name area during a part of the construction phase namely in the spring (March – May) and in the autumn (September – November).

In general the effects will be greater in the enlarged concession (approx. 14.5 km²) than in the original concession (approx. 9.0 km²). In worst case an area of approx. 0.40 % of the BPNS will be affected, so that the magnitude of disturbance remains limited.

The impact during the construction phase is temporary and only affects a small area (max. 0.40 % of the BPNS). For all foundation types (monopile/ multipod/ jacket) and capacities (3 to 7 MW) the impact is therefore judged to be slightly negative (0/-).

EXPLOITATION PHASE

Migratory birds and local bird movements

During spring and autumn Kittiwakes, Lesser black-backed gulls, Great black-backed gulls, Gannets and Northern fulmars are found in high densities in the Bank With no Name area. Exactly which bird species will be disturbed by the wind turbines during the migrating periods and which ones could collide with the wind turbines is difficult to predict. The Bank With no Name is probably situated on the migration route of some offshore species, but observations carried out by Vanermen *et al.* (2006) show that the stream of migrating birds is most intense along the coast; further out at sea it is more spread out.

On the basis of the sensitivity score (Vanermen *et al.*, 2006) the disturbance effect on the seabirds found in increased numbers in the Bank With no Name area during the migrating periods will probably be minimal. The species found are namely moderately sensitive to disturbance. On the basis of the collision vulnerability score (Vanermen *et al.*, 2006) and the densities on the Bank With no Name during the migrating periods in spring and autumn, it can be expected that Kittiwakes, Great black-backed gulls and

Gannets in particular will be among the victims of collisions. However, the chance that Gannets and Kittiwakes will fly within reach of the rotor blades (> 25 m) is small: just 4 % fly at the height of the wind turbines (Vanermen *et al.*, 2006), so that it may be expected that the actual number of victims among the Gannets and Kittiwakes will be small. Great and Lesser black-backed gulls are flying highest: namely respectively 14 % and 12 % of the species were found within the reach of the rotor blades (Vanermen *et al.*, 2006). Due to their large dimensions, their low manoeuvrability and their flying height, these species will be most vulnerable to a collision. Among the victims of collisions, the number of Great and Lesser black-backed gulls will be probably high.

In case 3 MW turbines are chosen, the risk of collisions will be higher – if the total capacity of the wind farm remains the same - than with 7 MW turbines. In general, the higher the number of turbines, the higher the disturbance. Therefore the maximum effect will be expected for the 3 MW-configuration in the enlarged concession area (in total: 72 turbines).

During the so-called 'fall-conditions' several songbirds can fall victim to the wind turbines. This effect cannot be properly assessed as yet; further research concerning these 'fall-conditions' is needed.

The overall impact (disturbance and collision risk) of the wind farm (for both the original and the enlarged concession area), for the different foundation types (monopile/ multipod/ jacket and gravity foundation) and capacities (3 MW to 7 MW), on migratory birds in the Bank With no Name area is judged to be slightly negative (0/-). The effect on songbirds is hereby a knowledge gap.

The impact on local bird movements will most likely be marginal, but no reliable information about this is available.

Resting, foraging seabirds

Which species among the resting and foraging seabirds will actually be disturbed by the working wind turbines and which will be colliding with the wind turbines is difficult to predict. It may be assumed that it will be the Guillemots who will be disturbed most, as they are sensitive to disturbance. Based on the collision vulnerability score (Vanermen *et al.*, 2006) it is expected that Kittiwakes are most likely to collide with the wind turbines. In a study by Vanermen *et al.* (2006) on estimated flight heights of seabirds, only a small percentage of Kittiwakes were observed within reach of the rotor blades, so that the number of victims among the Kittiwakes will be small.

The overall impact (disturbance and collision risk) of the wind farm (for both the original and the enlarged concession area), for the different foundation types (monopile/ multipod/ jacket and gravity foundation) and capacities (3 MW to 7 MW), on resting and foraging birds in the Bank With no Name area is judged to be slightly negative (0/-). The area no longer available to the resting and foraging seabirds is small (0.25 % (original concession) to 0.40 % (enlarged concession) of BPNS). In case 3 MW turbines are chosen, the risk of collisions will be higher – if the total capacity of the wind farm remains the same - than with 6-7 MW turbines.

DISMANTLING PHASE

In general the effects of the dismantling phase can be expected to be similar to those of the construction phase.

CABLING

The installation of the cables can result in a temporary disturbance of the avifauna by a change in food availability or altered turbidity in the water column. Disturbance of the sediment will cause increased turbidity which can affect fish with filter mechanisms and reduce the visibility for the birds feeding on fish. The Common scoter and Red-throated diver species are the most sensitive to disturbance. As they are fish-eating birds, they can also be most affected by an increase in turbidity caused by the installation of the cables. Because these effects are only temporary and of limited magnitude, the impact on avifauna as a result of the cable installation is estimated to be slightly negative (0/-).

The presence of the cables during the exploitation phase will probably have no direct impact on the avifauna.

4.5.2.3 Sea mammals

CONSTRUCTION PHASE

During the construction of the wind farm some disturbance for sea mammals can occur as a result of the activities being carried out, such as increasing turbidity of the water, underwater movements, noise and other activity on the seabed. The construction activities generating an increase in the underwater sound level and vibrations, in particular the ramming of piles with hydraulic hammers, are the activities that are largely responsible for a negative impact on sea mammals.

The effects on sea mammals vary between disturbance (till several ten km from the sound source), permanent physical damage (within some hundred meters of sound source) and even possibly mortality. Another aspect of noise disturbance on organisms is the duration of the sound: exposure of short duration is less damaging than a long exposure to the same sound level (BMM, 2007c). It is expected that sea mammals will temporarily leave the construction site and the surrounding area. After the construction phase is over the sea mammals will probably return to the wind farm.

Although the effects of pile-driving only last for a while, it is advised to provide temporary deterrent mechanisms in order to minimize the risk of damaging the hearing of the sea mammals. If this mitigating measure is taken into account, the effect of pile-driving on sea mammals is judged to be slightly negative.

The construction of wind farms can also affect the food sources for sea mammals (e.g. dwindling fish populations). The areas may become less attractive for the sea mammals and they may leave. The decline of the food sources is likely to be temporary and will recover again when the construction of the wind farm is finished. It is also expected that the sea mammals will return to the area as soon as the food sources have returned to normal.

In view of the short duration and limited spatial spread (0.25 % (original concession) and 0.40 % (enlarged concession) of BPNS) of the activities, the mobility of sea mammals and the current number of sea mammals seen in the BPNS area, the effects of the work during the construction phase will be limited and not permanent. The impact during the construction phase is judged to be slightly negative (for both the concession scenarios) if some of the mitigating measures during piling are implemented.

EXPLOITATION PHASE

Working wind turbines will produce noise and vibrations that will probably have an impact on sea mammals and be heard by them. The effects of the noise and vibrations of the 3 and the 6 MW wind turbines can in this moment in time not be estimated because there is a lack of research data, but no great disturbance impact like trauma or mortality is anticipated. Acclimatization may occur.

The physical presence of the wind turbines (e.g. reflection in the sun, shadows of the rotating rotor blades) may have an impact on certain sea mammals and cause them to use the area less or abandon it completely. But sea mammals could also be attracted to the area: to use it as a resting place or as a defence against predators. The effect of the physical presence of the wind turbines on sea mammals is judged to be negligible. Over time the sea mammals could get used to them.

It is expected that the maintenance activities will have a disturbing effect on sea mammals. This effect is judged to be only slightly negative because of its temporary nature and the relatively small area of the BPNS that will be affected. Moreover, the sea mammals are expected to develop some tolerance to the maintenance activities on the wind farm as they get used to them.

When the foundations and erosion protection have been installed a new, artificial, hard substrate may be created, which can attract more epifauna and epiflora and consequently prey fish too. During the exploitation phase there could therefore be an increase in the number of sea mammals in or around the wind farm, due to the availability of more food around the foundations or other food sources becoming available, but possibly also because of reduced fishing activity in the area. It is expected that more sea mammals will be attracted around a gravity foundation than a monopile or multipod/jacket construction, because it is likely that a gravity foundation will attract more fish. As a consequence this can have a positive influence on the sea mammals.

The impact on sea mammals during the exploitation phase is judged to be slightly negative (0/-) for both the original and the enlarged concession area. However, as possible effects can be chronically during a longer period, monitoring of the effects is advised.

DISMANTLING PHASE

In a worst case scenario it can be expected that the effects during dismantling will be comparable with the effects during construction: disturbance will occur of the sea mammals. However, as during dismantling no piling and dredging will occur and as the hard structures will remain in place, the disturbance shall be lower than during construction.

Tthe effects of the dismantling phase on sea mammals are therefore expected to be slightly negative (0/-).

CABLING

The installation of the cables can have an effect on sea mammals. This effect however is temporary, limited in size and therefore judged to be only slightly negative. After installation of the cable the surroundings will restore. During the exploitation phase the magnetic fields, generated by the cables, will probably not have a discernable effect on the sea mammals. Sea mammals are mainly found in the water column, where the effect of magnetic radiation tends to be limited.

The effect of the cabling on sea mammals is expected to be slightly negative (0/-).

4.5.3 Mitigating measures

4.5.3.1 Invertebrates and fish

During the discussion of the effects a number of knowledge gaps were identified: species-specific influence of noise and vibrations, the effect of electromagnetic fields and heat generation. Apart from that, some ambiguity still remains about the impact of the introduction of hard substrate in the naturally sandy biotope. In view of this lack of knowledge it is difficult to specify detailed mitigating measures. The emphasis is therefore on an adequate monitoring programme (consistent with other wind energy initiatives) that tries to fill in these knowledge gaps.

4.5.3.2 Birds

As far as the mitigating measures is concerned, attention must be paid to the introduction of the necessary warning systems, in case that experience shows that these measures effectively reduce the risk of collision.

It is advisable to be acquainted with the reference situation as regards the prominent bird species before construction begins. If investigation of the reference situation shows that the area where the wind farm is to be built is an important resting area for certain seabirds (in particular for Divers, Guillemots, Razorbills), it is essential to ensure that protected areas are reserved or existing areas extended elsewhere in the BPNS.

4.5.3.3 Sea mammals

In spite of the temporary nature of the pile-driving, and the apparent limited presence of sea mammals in the vicinity of the project, some mitigating measures are proposed. Belgium has internationally (European Habitat Directive, ASCOBANS) committed itself to protect sea mammals and to avoid if possible negative impacts (in particular acoustic disturbance). Therefore the use of mitigating measures during pile -driving such as the use of deterrents and a "ramp-up" procedure in which the power during pile-driving is slowly increased, are recommended.

If it should become apparent that, during certain stages of the installation process of the foundations, noise is generated that is comparable with pile-driving noise or that is potentially dangerous for sea mammals, the same condition still applies.

4.6 SEA VIEW & CULTURAL HERITAGE

4.6.1 Reference situation and autonomous development

The sea and the beach are regarded by the population as an asset. In Belgium the coast is an important tourist attraction, for day trippers as well as holiday makers.

In contrast to the sea view, the coastal view in the inland direction is characterized by a range of high-rise buildings.

Movement in the landscape by ships are part of the landscape experience of people on the dikes. Especially near the seaports there is a continuous coming and going of ships. This movement in the landscape generated by freighters, fishing boats, pleasure boats and surfers, is observed by many people, especially when the weather is sunny and clear.

Along the coast there are a great many heritage sites, either protected or not protected. The most important ones are a number of dune areas and polders, piers, lighthouses, a fort of Napoleon etc.

At sea the cultural heritage consists mainly of wrecked ships. There are no shipwrecks in the Bank With no Name area. On the cable route to Zeebrugge there are some wrecks mainly near the Vlakte van de Raan.

4.6.2 Impact description and assessment

During the construction of the wind turbines there will, to a certain degree, be a temporary visual change of the landscape on shore (building site in harbour) due to the pre-assembly of the turbines and other parts of the wind farm as well as at sea caused by the additional shipping, the presence of all kinds of technical material, such as platforms, etc. near the Bank With no Name. This can result in an increased touristical activity. This perception can be seen as negative (disturbance inhabitants) or positive (touristical attraction), but is judged as almost non-existing (0) compared to the other described effects.

The construction of the wind farm will not have any direct or indirect effect on the cultural and landscape heritage along the Knokke-Ostend coast.

In view of the fact that the wind farm will be situated in the sea at least 35 km from the shore, the construction activities at sea or the actual wind turbines will hardly be visible. It is expected that the wind turbines will only be visible in clear weather. The visual impact of the project is therefore judged to be almost non-existing, for both the original and the enlarged concession area. In addition it can be said that the presence of a wind farm will be experienced by some people as being attractive or restful.

During the construction and exploitation, measures to ensure the safety of shipping, aviation and fishing must be put in place. It is imperative that the specifications (IALA Directive O-117 and O-114; Circulaire Bebakening Hindernissen, 12/06/06) of the proper authorities are adhered to.

As described in the reference situation some wrecks are found on the cable routes to Zeebrugge. It is indicated for the route to be adjusted to ensure that no wrecks are affected by the cable installation.

The effects on the sea view and the cultural heritage will be the same during the dismantling phase as during the construction phase. As stated before, this impact is judged to be negligible (0/-).

4.6.3 Mitigating measures

It will be necessary to scan the seabed in order to keep the impact on the wrecks that are present to a minimum. This can be done for the various planned wind farms all at once.

To reduce the disturbance as much as possible, it is advisable that there is a fine-tuning of the construction works between the different wind farm initiatives.

4.7 MAN

4.7.1 Reference situation and autonomous development

In the Belgian marine areas the following users can be identified: shipping, fishing, mariculture, aviation, sand and gravel extraction, dredging and dumping of dredging mud, gas pipelines and telecommunication cables, military use, wind energy projects, oceanic observation stations, tourism and recreation, scientific research. The seabed is also strewn with shipwrecks and certain areas are protected areas of natural value (Ramsar, Natura 2000, Birds and Habitats Directives, special protection zones (SBZ), etc.).

Both the concession zones in question are used for fishing and military exercises. In the vicinity are shipping routes, extraction zones, cables and pipelines and the concession areas of Belwind (wind energy) and C-Power (wind energy + mariculture). The intended cable route to Zeebrugge does not cross any of the existing operational cables or pipelines, but will cross the shipping route “het Scheur” and the protected nature area SPA-3.

In the non-technical summary we will only describe those activities that are actually taking place within the concession area. As there are no interactions with other activities in the near vicinity or further away in the BPNS, these activities are not discussed here. In the main document of this EIR, the activities in the vicinity are briefly mentioned however. In general it was concluded that the construction and exploitation of the Eldepasco wind farm will have no negative impacts, both for the original and enlarged concession areas.

4.7.1.1 Fishing

Fishing for flatfish (plaice, sole, flounder) with trawlers is the main fishing activity in the BPNS area and is carried out predominantly in the gullies between the sandbanks. Shrimp fishers on the other hand will look for their catch on the sand banks, mostly nearer the coast.

On an international and national scale the fishing sector is faced with socio-economic problems by 1) a steady decline of the existing biomass in the higher trophic levels in the North Atlantic since 1950 and 2) increased fishing intensity during the 1950-1975 period. Researchers have found that the current fish exploitation cannot carry on and that due to the existing trends the higher trophic level of fish in the North Atlantic will disappear completely in the next few decennia (Christensen *et al.*, 2002). This is also evident from the fact that the stocks of nearly all species are specified as being "outside safe biological limits".

Belgian fishing showed an increase in supply between 1950 and 1955, after which a steady decrease in supply and fleet size (end 2006: 107 vessels) was noted. The economic situation in the Flemish sea fishing industry is a source of great concern for the people involved, due to a yearly decline in profitability. Especially for the boats in the Large Vessel Sector the figures show a sharp decline in profit (-13.8%) due to a steep rise of the costs in relation to the turnover. This increase in costs can mainly be attributed to a rising gas oil price since 2005. The relative supply (% share) of the various fish species has hardly changed at all. The dwindling supply and rising costs were compensated to some degree by a general rise in the price of fish during the last few years.

Developments in the European Fisheries policy lead us to believe that further quota restrictions and accompanying measures (such as technical measures and restricting the days at sea) will mean that the trends described above will only grow stronger in the short and medium term.

4.7.1.2 Military activities

The concession area of Eldepasco (original as well as enlarged concession) is situated in the military zone where artillery exercises with floating targets are held. As this military zone overlaps the wind concession zone for a large part, marked off in accordance with the Royal Decree (RD) of 17/05/2004, the government has agreed that within the confines of the offshore zone (in accordance with concession RD) no military exercises will be held. However it has been agreed that they can continue temporarily as long as the turbines have not actually been installed. In due course the military exercise zone will be moved a little so that there will no longer be any overlap. (Cathy Plasman - Advisor Cabinet of Minister Landuyt, Ministry of the North Sea)

4.7.2 Impact description and assessment

4.7.2.1 Fishing

One of the studies consulted for this description of the impact on fishing was the one carried out by Mackinson *et al.* (2006) on the views of the fishing community about the potential socio-economic impact of offshore wind farms on their sector.

The potential loss of access to traditional fishing grounds is generally seen as the most important negative effect of the development of wind farm projects at sea. The installation of this wind farm (including the safety zone) would lead to an additional loss of fishing grounds of 0.50 % (original concession) to 0.68 % (enlarged concession) for the BPNS. The impact as a result of the wind turbine project as described is therefore small (0/-) and is furthermore far less relevant than the loss of income caused by the fluctuating fuel prices and the restrictions imposed by the European Fisheries policies. Moreover, a recent scientific study shows that the closure of small areas to trawler fishing could have a significant positive effect (++) on the fishing in nearby areas (bigger catches).

Apart from the spatial loss, the fishing community has concerns about the short and long term effects during the construction phase and exploitation phase. During the construction phase pile-driving is seen as the main cause for changes in fish behaviour, while the cable installation will temporary disturb the sediment. The main impacts expected during the exploitation phase are the changes in fish behaviour as a result of the electromagnetic radiation generated by the cables and the introduction of hard substrates (Mackinson *et al.*, 2006). However there is some uncertainty about the size of this impact and the species-specificity. For a description of these effects and the knowledge gaps on this subject, see chapter "Fauna and Flora".

4.7.2.2 Military activities

Due to the infrequency of the military activities (maximum of 5 exercises per year) in this zone, no effects of the planned wind farm project (both for the original and enlarged concession) on these military activities is anticipated.

4.7.2.3 Other activities

No conflict with all the other human activities on and in the Belgian marine waters is expected to arise during the construction and exploitation of the wind farm. These activities occur at a large enough distance from the wind farm and its cabling or the activities are separated in time.

Crossing of the shipping routes will be done in consultation with the responsible authorities and in accordance with international safety regulations. It is assumed that the cabling of the wind farm will cause no impact.

The only possible conflict from an environmental point of view between the wind farm project and the protected areas mentioned is the fact that the proposed cable route to Zeebrugge runs through the special protection zone SPA-3. On the strength of the impact description in chapter "Fauna and Flora" and the conclusions of the assessment within the context of the Royal Decree 14/10/2005, the effects are temporary and local (0/-) and therefore no significant effects are anticipated for the protected nature areas.

4.7.3 Mitigating measures

No mitigating measures or compensations are proposed for the development of the wind farm Eldepasco.

4.8 SAFETY

In the EIR various kinds of safety risks are discussed. Risks for the workforce (occupational hazards) are not discussed in this EIR. Moreover, the consequences of accidental oil pollution are described in this chapter.

The reference situation, effects on and by the shipping industry and relevant mitigating measures are established in a monograph by DNV (October 2008, Appendix 5). The reference situation, effects on radar, shipping communication and navigation systems, and relevant mitigating measures are established in a monograph by Prof. Catrysse (April 2007, Appendix 6). The most important conclusions can be found here.

4.8.1 Reference situation and autonomous development

4.8.1.1 Installations

There are no installations on the Bank With no Name as yet.

4.8.1.2 Shipping traffic

The Belgian Part of the North Sea (BPNS) is an intensely used marine area. The most important shipping lane is west-east orientated in the direction of the Scheldt (Zeebrugge). Around the Bank With no Name two shipping lanes are situated: one NW (mainly ferry traffic) and to a lesser degree also one SE of the project area (Westrond 1). A detailed description of these different shipping lanes can be found in the EIR of C-Power (Ecolas, 2003) and in the RAMA-study (Le Roy *et al.*, 2006).

In the available literature (EIR C-Power, RAMA-study, DNV, MARIN) different sources are quoted with comparisons on the chance of an accident. These numbers vary enormously (from several accidents per year to less than 0.0005/year), depending on the considered area, the shipping type and the type of accident (grounding/ drifting; with ship/ offshore obstacle). An insight in the actual chance of an accident on the BPNS is therefore difficult to estimate.

The chance of an accident resulting in oil pollution is also subjected to variation: once every 30 year (MUMM) to once every 3 year (RAMA-study), with an average spilled quantity of 1,470 ton/year for a cargo-incident (RAMA-study).

To conclude, it is very difficult to estimate the accident and spill risk in the Belgian territorial waters. Therefore prudence is in order when interpreting the figures, taking into account the mentioned uncertainties. Since there is no unambiguous conclusion about the accident risk in the southern North Sea, a comparison with the additional risk due to the Eldepasco project will be difficult to interpret.

4.8.1.3 Radar and ship communications

Along the Belgian and the southern part of the Dutch coast a series of coastal radars has been installed, the so-called Scheldt Chain of Radars (or SRK). The purpose of these radars is to help the authorities in organising the shipping traffic in the southern part of the BPNS, the Scheldt estuary and the southern Dutch marine coastal waters.

The Bank With no Name is situated off the Zeebrugge coast, close to the Dutch border and 34 km from the radar installation of Zeebrugge. The sand bank is situated approx. 8 km north of the Thorntonbank and approx. 5 km south of the Bligh Bank. Data supplied by, amongst others, SRK show that there is to a limited degree shipping traffic in the area between the Bank With no Name and the Thorntonbank, the so-called 'West-rond' route. The SRK harbour radar of Zeebrugge is able to follow this traffic, although it is not within the "official" SRK surveillance domain. The main shipping route from the Channel to Rotterdam (Noordhinder route) lies much more northerly than the Bank With no Name, and is outside the range of the SRK radar stations (Catrysse, 2007).

For a detailed description of the coordinates, the frequencies and capacities of the radar stations and the mariphone installations and systems, reference is made to the tables in the monograph by Catrysse (2007).

4.8.1.4 Oil pollution

As the project area lies in the North Sea it is subject to the regulations that apply to the MARPOL "special zones", Appendix I. The dumping of oil-bearing liquids is prohibited. The intern regulations and controls are supposed to be effective so that no spills should occur. In practice it must be concluded that illegal oil polluters continue to play a large part in the oil pollution in the North Sea (for example, see Ospar Commission, 2000).

Oil pollution could occur in two ways. The first is an unexpected leakage of oil-bearing substances from a ship (e.g. in the construction phase or as a result of an incident or accident involving ships that have no connection with the project) or from an illegal discharge. The second possible cause of oil pollution could be an incident with a wind turbine or an incident on the transformer platform, resulting in the spilling of oil or oil-bearing lubricants.

In the southern part of the North Sea some (oil) pollutions were observed in the vicinity of the project area, going from < 1 m³ to 1-10 m³. It is not clear if these where the result of unexpected leakage or illegal discharge. The chance that an illegal discharge is observed, is rather small. However, a decreasing trend can be observed, probably as a result from the control flights by planes.

From a historical analysis (from 1960 – 2003) of accidents involving oil pollution that were a potential danger to the Belgian coast it appears that during the last 40 years approximately 30 such incidents have occurred. The main causes are collisions (70%), followed by incidents resulting from a wrong manoeuvre (7%). The volumes spilled vary from 10,000 tonnes to less than 10 tonnes.

The recent requirement for tankers to be double-walled means that the oil spilled as a result from shipping accidents will in future probably be mainly bunker oil.

No unambiguous information was found about the correlation between the occurrence of oil pollution (quantity; type) and the type of accident. On the other hand data from reported oil pollutions by several types of tankers on world scale show that collisions mostly resulted in larger spills (> 7 ton) and that cracks in the hull of the ship mostly lead to small scale pollution.

4.8.1.5 Air traffic

For the sake of completeness, the safety for air traffic is briefly discussed in this EIR too. Although the wind farms are situated in Belgium the air traffic in this area is controlled by Schiphol and not Zaventem. Within the marked CTR (Control Terminal Region) zones there is an altitude restriction of 150 m, but the wind farms are not situated inside them.

4.8.2 Impact description and assessment

4.8.2.1 Installations

The wind turbines of Eldepasco are subjected to various classification systems. In order to belong to a certain classification the turbines themselves and their components are tested (rotor blades, nacelle, electrics, mast and foundation). The wind turbines have a type certification in accordance with IEC 61400 or equivalent.

For safety reasons it is important to establish what the chances are of objects or activities in the vicinity of the turbines being hit by, for instance, a broken-off rotor blade. The maximum throwing distance during an overrev-situation (2 times nominal number of revolutions) for a 3 MW wind turbine turns out to be around 436 m. For a 5 MW and 7 MW wind turbine the throwing distance will be about the same. In principle this risk will be covered by the safety zone of 500 m for ships around the wind farm.

Provisions for the protection of the environment are included as standard for the wind turbine and transformer platform installations. The amount of oils and grease in the turbine is approx. 300 kg of grease and 1300 litres of oil per turbine. It must be mentioned that the choice has not yet been made between dry or silicon-oil (in case of oil-cooled transformers) transformers. The transformer platform is a storage tank (double hull) containing diesel fuel (circa 30 m^3). Leakage of fluids (oil, grease, etc.) from the installation is prevented or minimized by the fitting of various collection systems (basins, brims) as well as the way in which the components of the installations are constructed. Assuming that these collection systems function properly and are well designed (certified), there will be no negative impact on the environment. This will not be the case if a wind turbine should collapse as a result of extreme climate conditions (extremely small chance; considering the existing classification and certification systems) or as a result of a collision by ships.

As there are usually no people in, or in the immediate vicinity of the wind farm, there are no risks or consequences for man. It must be noted once more that occupational hazards (that do exist) are not considered.

4.8.2.2 Shipping

The effect description of shipping is mainly based on two recent safety studies namely DNV (2007; 2008) and MARIN (2007). The results of the DNV (2008) study serve as a basis as this study has specifically analysed the risk of the wind farm Eldepasco (different configurations). The shipping data used for the DNV study were taken from the RAMA-study (Le Roy *et al.*, 2006) as with the start of the Eldepasco project (in 2006) these were the most accurate data. It is important to note that these data (period 04/2003 – 04/2004) were obtained from the IVS-SRK database and from ferry operators. On that moment no data from the Noordhinder Traffic Separation Scheme were already available at IVS-SRK (gap in knowledge). Secondly, the results from the MARIN study (2007) have been used in which the effects of shipping for the wind farm Belwind have been determined, but which includes also information about the Eldepasco project. The MARIN study is based on a new traffic database including the routed AIS (Automatic Identification System) traffic from the Dutch Coastguard (2005-2006). Possible differences in the results of both studies can mainly be explained by these differences in basic data and in the determination of the shipping routes.

In general, the wind farm could obstruct the current shipping traffic, as the shipping route will have to be changed in order to avoid the wind farm. This is mainly true for the Westrond 1 route situated southeast of the project area. The RAMA-study (Le Roy et al., 2006) shows however that the use of the route is very limited (only 100 ship movements/year). The new AIS data (MARIN, 2007) speak about 1000 ship movements per year on the same route. Compared to the traffic on other shipping routes the frequency is nevertheless low, so that we can conclude that the disturbance for shipping is minor to the priority of wind energy production in Belgium.

During the construction and the dismantling phase there will be additional shipping traffic between the wharf and the project site. The increased work traffic will increase the risk on an accident at the BPNS, but it is expected that due to the limited number of ship movements the additional risk will be lower than the natural variation of risks to be expected at the BPNS, based on the variations in shipping density.

The other danger during the construction and the dismantling phase is the risk of a passing ship (from outside the project) colliding with a wind turbine (monopile construction, worst-case scenario). These risks are probably comparable with the risks during the exploitation phase.

In the monograph by DNV (2008) the total risk on a collision/drifting without a tug is estimated at 1.27 10^{-3} per year (once every 788 year) and 8.50 10^{-4} (once every 1,178 year). This risk is mainly due to the risk of drifting respectively once every 839 year and once every 1,259 year (situation without tug). The powered collision risk is much lower: maximum once every 12,740 year (enlarged concession; 72 turbines). Based on the results of DNV (2007), the use of a tug has no effect on collisions, but means a reduction of drifting risk of 50 %. These results are also confirmed by other studies (a.o. Koldenhof & van der Tak, 2007; MARIN, 2007).

A comparison with available literature shows that the estimated risk for the wind farm on the Bank With no Name (considering all the ship traffic) is low (MARIN, 2007) to very low (DNV, 2008).

Besides the risk of a ship colliding with a wind turbine/ transformer platform, the spill risk of such an incident has been estimated. The spill risk is dependent of a number of factors (e.g. the size and type of the ship; the speed at collision; the place of collision, etc.).

In general, the larger the ship, the smaller the impact of the obstacle on the ship will be, but the larger the impact on the obstacle. Besides, the damage on the ship and obstacle will increase with the speed. The EIR C-Power (Ecolas, 2003) shows that based on expert estimations a drifting ship of 10,000 GT (= 3/4 of all ships) will sail over the turbine, resulting in the fall down of the turbine on the sea bed or in severe damage of the transformer platform (this chance is very limited due to the central location of the transformer in the park).

It is clear that the specific characteristics of the type, the form and the construction of the ship will influence the effects of an incident. There will be a difference in impact in case of a rupture of a bulk carrier, a single hull oil tanker or a general cargo or container ship. The location and the volume of the bunker tanks are also dependent on the ship type.

The environmental risk of a collision/drifting of a wind turbine is defined by the quantity of oil spilled by the ship. DNV (2007) shows that the total yearly spilled oil is low (approx. 0.2 ton/year) for all considered scenarios and that this is mainly due to the spilled tanker oil. If supposed that all incidents result in an oil spill, than the spilled oil quantity in case of a collision with an oil tanker is estimated between 100 and 500 ton and the average spilled bunker oil is approx. 20 ton. Starting from the statistical finding that only 1 on 5 incidents result in an environmental risk, the spilled quantity is estimated 5 times higher (but with a frequency that is five times lower).

The risk from the wind farm is thus limited, but not negligible for the shipping safety. The conservative risk (= frequency x impact) is classified as acceptable by DNV, as the estimated risks on the Bank With no Name are in general lower than the ones for other wind farms. On the other hand it should be noted that human failures where not taken into account in this study and that the lack of Noordhinder data are probably causing an underestimation of the results. The accident risk on the Bank With no Name (36 * 5 MW) is estimated by MARIN (2007) at 0.027 per year (approx. once every 40 year). In spite of this significant increase, the risk for Eldepasco is low compared to the individual risk of the two other wind farms and is therefore judged as acceptable.

4.8.2.3 Radar and ship communications

According to Catrysse (2007) the dominant factor for mariphone systems is the mast for large wind turbines. Large reflecting objects can also have an effect (e.g. dead areas, multiple reflections, etc.). The effects should however be seen in relation to the position of both the radio/radar system as well as the configuration of the wind farm. Taking into account the location of the Bank With no Name in relation to the coastal stations, the potential effect of receiver saturation could only affect the ships radar (Catrysse, 2007).

The installation of the wind turbines on the Bank With no Name will not interfere with the radar tracking by SRK. Firstly, the installation lies outside the range of most radar posts. Secondly, the situation will not change for the shipping traffic passing in front of the Bank With no Name. In the area behind the Bank With no Name there will be shadow zones, affecting radar tracking as well as other mariphone systems. But this area is almost out of range anyway. Other effects will depend on the completion of other projects and the potential installation of wind farms (see chapter "cumulative effects"). The type of wind turbines (with as type examples the 3 MW and the 6 MW) does not influence these situations.

The influence of potential multiple reflections affecting the ships radar is noticeable within a zone of approx. 1 km from the wind farm. Still it is clear that these potential multiple reflections will not necessarily lead to dangerous situations and could give a false radar image only inside or in the near vicinity of the wind farm. There will never be a false echo resulting in a false image between the ship and the first object near the ship.

As far as the mariphone VHF (very high frequency) communication is concerned there are some reservations but only for the communication on the far 'Westrond-North' route (behind the Bank With no Name) and far-away routes. But here too, it must be made perfectly clear that for the area in front of the Bank With no Name there will be no changes compared to the current situation and that this is only possible in the area behind the Bank With no Name. Here too the real restriction is the actual range of the radio installations.

Catrysse (2007) shows that the influence will rather be minimal or non-existent on the following systems:

- RDF (Radio Direction Finder) systems
- DGPS system
- AIS (Automatic Information System)

According to Catrysse (2007) it can be assumed that the realization and installation of an off-shore wind farm on the Bank With no Name will almost have no impact (effect = 0) on the surveillance of and communication with the shipping traffic as it is now.

4.8.2.4 Oil spread and ecotoxicological effects

In addition to analysing the risk of an accident, attention was paid to the potential impact of oil pollution from a shipping accident resulting in an oil spill of 1,000 ton. For the purpose of the EIR for the wind farm on the Thorntonbank (C-Power), WL Delft Hydraulics has carried out mock-ups to simulate the spread of an oil spill in the environment. Here follows a description of the worst-case scenario, whereby all the contributing factors (wind force, wind direction, amount of oil, season, wind friction,…) were selected to maximize the impact on the environment.

After extrapolating the simulation data of WL Delft Hydraulics, it appears that with strong winds the oil slick would reach the Belgian coast in 12 hours. In these circumstances there would be a relatively short time for intervention. With more moderate wind speeds there should be enough time to allow intervention.

The presence of a wind farm on the trajectory of an oil slick has positive as well as negative effects. The wind turbines could be used as anchor points for floating barriers, but on the other hand the turbines themselves could be an obstacle for manoeuvres during the combat and break up the oil slick into several smaller ones.

The quantitative impact of a discharge of 1.000 tonnes of heavy fuel oil on animal life depends in many ways on the scenario in question and the animal group concerned. The estimated direct impact (death within a few days) on fish and invertebrates is extremely small and will always be less than 0.2 % of the local populations.

Bird losses at sea were estimated at some tens to hundreds, depending on the weather circumstances. The modelling results should be handled with care, as actual accidents on location often prove that in reality these numbers will be higher. There is no positive correlation between the number of bird victims and the amount of spilled oil. The effect is closely linked to the importance of the area as a wintering place for birds. In addition to the victims that will be killed as a result of a disaster, there may also be negative effects for the population (long-term effect). It is however not always easy to separate the actual impact of the disaster from the natural fluctuations in a population. Bird losses as a result of oil being washed ashore on the Belgian coast, based on these scenario mock-ups, are judged to be negligible (i.e. 4 birds). These estimates only apply to the species listed in the vulnerability index; mortality among other occurring species that could be affected is not taken into consideration due to a lack of data. The oil slick could reach the Dutch coast later on and increase the number of bird losses.

For the qualitative oil pollution impact description it is stated that avifauna, and possibly sea mammals too, will experience the most important short-term effects. The plankton community will also be affected, but will recover very quickly. The impact on pelagic fish is negligible. The benthic fauna will probably not be affected by acute toxic effects, but thick oil layers (on beach) can cause them to suffocate. It must however be taken into consideration that such effects strongly depend on various factors that could influence the oil pollution. On the basis of availability of data in existing literature (or lack of it) it is therefore not possible to make a scientifically sound declaration about the magnitude of the effects on all benthic fauna and sea mammals in this part of the North Sea.

According to the study by Lindgren & Lindblom (2004) solid ecotoxicological data are difficult to find and incomplete. In general, the lighter types of oil appear to be more toxic than the heavy types. Pelagic organisms will suffer less than benthic organisms because of their sensitivity to exposure. Eggs and larvae are more vulnerable than fully grown specimen (Lindgren & Lindblom, 2004).

4.8.2.5 Air traffic

In principle, a total height (height tip of rotor blades) of up to 175 m should be acceptable. All the same a "permit" to erect high structures must be requested from the people responsible at the FIR (Flight Information Region) at Amsterdam-Schiphol, (Johan Catrysse, personal communication).

4.8.3 Mitigating measures

4.8.3.1 Installations

Adequate sensors and regular inspections could be foreseen on the places where leakages can lead to significant spill quantities of oil or grease to minimize the environmental risk. In this way the operator can detect rapidly the leak and intervene.

In case of a spill caused by an incident or accident and threatening the environment, the harmful substances must be removed as soon as possible and processed according to current regulations.

4.8.3.2 Shipping traffic

The different results of the safety studies show that there is a lack of uniformity around the use of risk models and input data. A streamlined policy from the responsible authorities on the execution of risk analysis studies making use of f.ex. one model that is up-dated according to the most recent shipping traffic and wind energy situation could make the risk estimations more clear and cost-efficient.

Despite, the following safety measures are proposed:

- In the safety zone of 500 m around the wind farm no shipping traffic is allowed.
- A tailor-made contingency plan must be available for incidents involving a wind turbine and for oil pollution in the vicinity of the wind farm.

- Foresee AIS (Automatic Identification System) transponders on the turbines on the corners of the wind farm and a radio channel connected to the control centre of the wind farm.
- Establish a safety procedure for the traffic moving to and from the site to minimize the risk of a collision.
- Equipping the wind farm with navigation lighting and radar reflectors, to maximize the visibility and detection for the shipping traffic.
- Potential surveillance of the shipping traffic around the wind farm, with adequate warning protocols and/or statutory regulations could increase safety.

Besides these safety measures on the level of the wind farm itself (initiator), some measures are mentioned – beyond the responsibility of the initiator- that are good for the general safety at sea.

- Equipping a maintenance ship as a multifunctional ship with additional functionalities such as tugging, firefighting, combating oil pollution, etc.
- Use of AIS (Automatic Identification System) transponders for all ships over 300 GT (approx. 55 m), which will reduce the risk of a ship colliding with a wind turbine (ramming) by 20 %.
- Use of a tugboat (like the Netherlands (De Waker)). According to information provided by the proper authorities (Belgian Structure Coastguard, Ulrike Vanhessche, personal communication) it is the plan that eventually a multi-functional ship could be used as a tugboat, to combat and reduce oil pollution, etc.

4.8.3.3 Oil pollution

In order to step up the combat against pollution, the Coastguard was founded on 1 May 2003 and is now up and running. Organising operations when oil pollution occurs is their most important task. According to information provided by the proper authorities (Belgian Structure Coastguard, Ulrike Vanhessche, personal comm.) there are currently two ships available to combat and reduce oil pollution:

- DAB (Dienst Afzonderlijk Beheer) Fleet;
- Navy ship (under the authority of the Ministry of Defence).

In the future a multi-functional ship will also be used by the Coastguard as a tug, to combat and reduce oil pollution, etc.

Since April 2005 (Ministerial Decree 19/04/2005) the new "Contingency plan North Sea" has come into force. The contingency plan describes the organisation of emergency services and the coordination of operations if disasters or serious accidents occur in the Belgian waters. The plan also gives operational and practical guidance.

In 2006 the scenarios "Operational intervention plans for the fight against pollution at sea and on the beach" were introduced. The scenario "Clean beaches", introduced in January 2006, suggests a procedure to tackle the pollution on our beaches or seashore by cargo or waste washed ashore. The scenario "Clean sea" (introduced in August 2006) does the same for the pollution of the sea.

Since early 2007 an intervention plan for birds is available from the Province of West Flanders. This is a scenario for the rescue and treatment of birds struck by oil pollution or another extreme situation at sea.

As mentioned in the project description, a ship that can transport maintenance personal, spare parts and material to the wind farm and the transform platform, will be used for the maintenance of the wind farm. It should be verified if that maintenance ship can be equipped with additional instruments and material to allow for other functionalities (tugging, fire fighting, combating, etc.).

Since the chance that the wind farm will cause oil pollution or any other pollution is very small, and therefore not likely to affect fauna or flora either, no additional specific mitigating measures will be necessary.

4.9 MONITORING

In the various thematic chapters, monitoring measures were proposed. These proposals were predominantly based on the EIR drawn up for the wind farm on the Thorntonbank (Ecolas, 2003 and Ecolas, 2004) and the environmental impact assessment (EIA) by the authorities for the same project (MUMM, 2004 and MUMM, 2006a) as on the EIA for the wind farm project on the Bligh Bank (BMM, 2007c).

If the monitoring carried out at the first wind park located on the BPNS proves to be representative for other wind farms to be installed subsequently, and if this monitoring shows that there are non-significant effects for certain sub- aspects, it will be sensible to adjust the monitoring requirements in order to gather supplementary information only.

In the relevant chapter proposals for monitoring are formulated for the cumulative effects of the three wind farms per theme. If possible the monitoring programmes of the various wind farms must be attuned to each other and synergies should be identified, in consultation between the MUMM and the three initiators. This should ensure that as many gaps as possible are filled and that financial efforts with regard to monitoring will produce a useful result.

5 CUMULATIVE EFFECTS

5.1 INTRODUCTION

The potential impact of a combination of several wind farms can, in connection with other human activities on sea, lead to an accumulation of effects. We could be talking about a relatively simple adding-up of all the effects of the various individual activities, but it could also be the case that certain effects intensify each other or indeed partly or completely cancel each other out. Alternatively it could also be possible that the individual effects must in fact be added up, but do not lead to significant problems for life in and on the sea and the habitats involved, until a hitherto unknown threshold value is crossed, after which significant problems may suddenly materialize after all. In that case we are dealing with a non-linear response.

In this chapter we will explore the potential cumulative effects of the 3 planned wind farms in the Belgian part of the North Sea (Eldepasco + Belwind + C-Power) for which a domain concession has been granted.

- C-Power n.v. has the required permits (domain concession and licence/authorization) to build a wind farm in the marine waters under Belgian jurisdiction in the Thornton Bank area and to exploit it for the duration of 20 years. In April 2004 they began with the necessary soil testing. In the fall of 2008 the first 6 wind turbines has been constructed. The concession area for wind energy is situated to the east of control zone 1, sector 1A. The concession on the Thornton Bank is divided into two areas: one on the western side of the telecom cable Concerto South1 and the Interconnector gas pipeline (sector A) with 24 turbines on an area of 5.0 km² and one on the eastern side (sector B) with 36 turbines on an area of 8.8 km². Including the safety zone of 500 m around the wind turbines a total area of 26.4 km² is taken up (Ecolas, 2003) for a total installed output of up to 300 MW (taking into account the safety zones). Meanwhile C-Power has applied for a change and extension of the original concession area (B.S. 10/10/2008).
- Eldepasco has obtained a domain concession (15/05/2006) for the construction and the exploitation of a wind farm of 36 turbines (ca. 9 km²) on the Bank With no Name located at ca. 38 km from the Belgian coast. On 29 of August Eldepasco has applied for a change and extension of the concession area to a total area of approximately 14,5 km². This EIR deals with the project in the original concession area generating approx. 144 MW (with 24 – 48 turbines) as well as with the extended project (with 36 – 72 turbines) with a total installed capacity of approx. 216 MW; the individual capacity of the turbines will be between 3 to 7 MW.
- Belwind, the Belgian subsidiary of the Dutch renewable energy group Econcern, has the required permits (domain concession and licence/ authorization) for a large-scale wind turbine project (330 MW) on the Bligh Bank. The wind farm will consist of 110 turbines of 3 MW. A domain concession for an area of 35.4 km² has been obtained.

Only those effects that have a non-negligible (positive or negative) impact on a certain discipline will be discussed in the next paragraphs. It is assumed that if a certain impact on the environment is totally negligible for each individual wind farm, the cumulative effect will be negligible too.

5.2 SOIL

For the three wind farms nearly 7.6 million m³ of sand in total will have to be laid up as a result of the excavation needed if each project chooses gravity foundations for all wind turbines. This will be done in stages over time: the construction will take 2 years; the construction period for each wind farm will differ. The cumulative effect will be smaller than the sum of the individual effects.

The impact on the morphodynamics of the BPNS caused by the installation of the cables is negligible. The impact will be reduced if the cables are laid together (adjacent cable routes) instead of each of the three projects using different routes.

Local erosion as a result of the constructions is prevented at the three wind farms by the installation of erosion protection a priori. When monopiles (multipod/ jacket structure) are chosen it can be concluded that the erosion protection in the three cases will be perfectly adequate. When gravity foundations are chosen there is some uncertainty due to a lack of scientific studies and practical experience and therefore initiators are taking even larger safety ranges for the dimensions of erosion protection. The cumulative effect will certainly be smaller than the sum of the individual effects. If local erosion should occur after all, it will be straightforward to negate the effect by making repairs and installing additional erosion protection.

If the erosion protection is removed it will leave a pit around every foundation. The space and time needed for the natural restoration of these foundation pits is, based on the information available to date, difficult to estimate. The cumulative effect will not be greater than the sum of the individual effects.

5.3 WATER

The construction of the foundation will cause, for each construction method and type of foundation but more so for the gravity foundation, a local and temporary increase in turbidity, which will have a negligible effect compared with the turbidity concentrations created naturally by strong winds. The cumulative effect is merely the sum of the individual effects.

The impact of the cable installation within each park and between parks and the mainland will be temporary and local. The impact (zone) would be reduced if the cables were to be installed together and at the same time (shared routes) instead of each of the projects using different routes or laying the cables along the same route but at a different time.

5.4 CLIMATE & ATMOSPHERE

An important effect during the exploitation phase is the prevented emissions on land as a result of the fact that the net electricity production of the wind farms does not need to be generated by traditional production (combined with nuclear production or not).

The prevented emissions of each wind farm on its own already make a considerable contribution to the targets set for Belgium for the reduction of SO_2, NO_x and CO_2. The cumulative contribution will obviously be even greater and is equivalent to the sum of the individual contributions (significant positive effect).

5.5 NOISE & VIBRATIONS

When during the construction phase the piles for the foundation are driven into the ground (in case the option monopole/ tripod is chosen), there will be an impulse sound (non-continuous). These pile-driving activities will be temporary only. Therefore the cumulative effect will not be greater than the sum of the effects per wind farm (the chances that pile-driving sounds from the 3 wind farms will be heard simultaneously are extremely small).

During the exploitation the underwater noise of the wind turbines is restricted to the area between the turbines and will not go beyond the safety border of 500 m around the respective wind farms, consequently the cumulative effect is equivalent to the sum of the individual effects.

Only between the Belwind and the C-Power wind farm in the Eldepasco wind farm area will the cumulative effect of the 3 wind farms together cause the noise level above water to be slightly higher. As the effect of the individual effects is expected to be small (of the wind farms separately), there will be a limited effect only of the noise above water coming from the 3 wind farms.

5.6 FAUNA & FLORA

For the majority of the effects on benthos and fish (loss of biotope, disturbance, loss of organisms, introduction of hard substrate, noise) the cumulative effect is the sum of the individual effects per wind farm. Also, these are often directly proportional to the space occupied. The total area of the three wind farms together (inclusive the safety zones) is relatively small compared with the BPNS (2.50 % - 2.75%). As most of the effects will only occur on a small part of the domain concessions (gravity > monopile/multipod/jacket) it can be concluded that on the whole the effects will be acceptable for both the original and the enlarged concession area. There is still a great deal of uncertainty about the magnitude of the cumulative effect of noise disturbance and electromagnetic radiation from the cabling. More research is needed.

Most cumulative effects on birds are the sum of the individual effects per wind farm. The cumulative effect as a result of the loss of habitat for resting and foraging birds will mainly affect species with pronounced avoidance behaviour, such as Razorbills, Guillemots and Gannets. As it may be assumed that the effects will be felt in a radius of approx. ca. 4 km around the wind farm, the entire concession zone demarcated on the BPNS for the construction of wind farms will be avoided by these species. In the first instance this cumulative effect is considered to be significant. In relation to the entire biogeographical population of these species found in the BPNS, the effect is judged to be moderately negative. As far as the cumulative effect regarding collisions is concerned, this is still seen as a knowledge gap. It is however anticipated that the collision effect will affect the big gulls most (Lesser black-backed gull, Black-backed gulls and Herring gulls).

No negative cumulative effects on sea mammals are anticipated. They are the sum of the individual effects. The cumulative effect as a result of rest disturbance is considered to be a knowledge gap.

5.7 MAN

No negative cumulative effects are anticipated for the various users of the North Sea.

For fishing and mariculture, the construction and exploitation of the various wind farms can have indirect positive effects as they will stimulate the fish population (areas closed to trawler fishing, shipping, …) and consequently the fishing in the area too, or provide opportunities to develop alternative ways of fishing.

5.8 SEA VIEW

The three wind farms are at such a long distance from the coast that they will be hardly visible. The wind turbines nearest to the coast will be visible in extremely clear weather only. These wind turbines will not be prominent enough to spoil the sea view, so no significant negative effect is anticipated. From the shipping route the turbines will be more visible but not affect the view much either.

5.9 SAFETY

There is a small negative (acceptable) risk of environmental pollution (from oil and grease spills) if a turbine topples over or if there is a complete structural collapse of the transformer platform.

In general it can be stated that as a result of the presence of the three other wind farms the total risk of shipping during construction will be more or less the same than the sum of the risk for the individual wind farms (max. additional chance of 0.057 accidents per year).

The individual risk of powered collision/drifting of the Eldepasco wind farm (once every 1,078 year) will decrease in the presence of the other two wind farms due to the shadow-effect (in comparison: individual risk Eldepasco - alone (worst case) once every 788 year).

For the three wind farms, a powered collision or drifting collision with a wind turbine on one of the three wind farms is expected to occur once every 9 years (Marin, 2007) to once every 23 years (DNV, 2008), depending on the study. As mentioned earlier, these differences can be explained by the differences in basis data and model characteristics.

The return periods could however be nuanced if possibly changes to or clearance of the existing shipping routes are taken into account. Based on the previous argumentation, the accident risk (powered collision/drifting) due to the three wind farms will be lower than once every 23 year (or once every 9 years) and is estimated at once every 100 year. Compared to the accident risk at the North Sea (once every 2.5 year according to DNV (2007)) this can be evaluated as an acceptable safety risk.

In principle no significant negative impact is expected on the surveillance of or communication with shipping traffic due to the presence and exploitation of the wind farms. To monitor the general security of the 3 wind farms in relation to the current ship traffic it will be advisable to set up an additional SRK radar. It is however obvious that Eldepasco will guarantee the safety measures within its wind farm, but that measures to be taken for the general security of the marine traffic (a.o. extra radar) is beyond the responsibility of Eldepasco.

6 CONCLUSION

Eldepasco has taken the initiative to build an offshore wind farm in the North Sea, to be located on the Bank With no Name. The aim of the project is to construct, maintain and exploit an offshore wind farm generating an output of minimum 144 MW (original concession area (ca. 9 km²)) and maximum 216 MW (enlarged concession area (ca. 14.5 km²)); individual power capacity of the turbine ranging from 3 to 7 MW. This capacity could supply approx. 120,000 – 180,000 households with electricity. The completion of this wind farm will help to achieve the objective of the authorities regarding renewable energy (6% by 2010; 13 % by 2020).

To assist with the decision-making process concerning the licence application, the procedure for an environmental impact report together with an environmental impact assessment will be followed. This EIR will be used to underpin the consents process and must describe the construction, exploitation, dismantling as well as the cable installation in the original concession (change of domain concession) as well as in the enlarged concession (extension of domain concession). Throughout the chapters the effects of the 3 MW (Vestas V90) and the 6 MW (6M REpower) will be discussed as type-examples, and where relevant a comparison has been made between the different foundation alternatives (monopile; multipod/jacket; gravity foundation).

The number of turbines depends on the chosen scenario. The offshore wind farm in the original concession area will be equipped with 48 (3MW) or 24 (6MW) wind turbines, together with 2 wind measuring masts and 1 power station. The offshore wind farm in the enlarged concession area will be equipped with 72 (3MW) or 36 (6MW) wind turbines, together with 1 wind measuring mast and 1 power station. The power will be transported to Zeebrugge via underground cables. The necessary controls regarding security and operation of the wind farm will be put in place, as well as illumination, marking and signposting. It will take 2 years to build the farm and its life expectancy will be 20 years minimum.

During the *installation phase* there will be temporary disturbance in the vicinity of the project site on the Bank With no Name as a result of the activities. With gravity foundations a considerable amount of surplus sand will have to be laid up in the concession area. As a result of the activities (ship movements, pile-driving, use of a crane, …) the sound level will temporarily increase underwater and above the water. There will be a temporary loss of benthic habitat and a limited and temporary disturbance of the benthic fauna and fish. There is some uncertainty about the size of the impact caused by noise and vibrations on the marine life. Species sensitive to disturbance and sea mammals will probably leave the area, but return after the construction phase. No effects are anticipated for other users of the BPNS. There is a limited negative risk of shipping accidents and environmental damage as a result of the shipping traffic to the project site.

During the *exploitation phase* there will be some effects also. Potential erosion in the area around each turbine will be prevented by the installation and monitoring of erosion protection around each turbine. The risk of water and soil pollution is negligible. During the exploitation of this wind farm approximately 0.3 % (original concession) and 0.4 % (enlarged concession) CO_2 emissions will be prevented in comparison with traditional power stations (significant positive effect). The wind farm will only be vaguely visible in exceptionally clear weather conditions. As the extension occurs in northern direction (further offshore), no additional negative effect on the seascape is expected. For the majority of fauna species there will only be a slightly negative impact. The creation of hard substrates will lead to an enhanced and changed biodiversity. Despite the increase of the described effects (~ surface) for benthos and fish for the enlarged concession compared to the original concession, the effects are still acceptable. During the exploitation phase the wind farm may cause hindrance (moderate negative effect) to bird species that are sensitive to disturbance and collisions. Sea mammals could be troubled by the vibrations, noise, maintenance activities and change in food sources during the exploitation phase. The effect on the avifauna and sea mammals during the exploitation phase is judged to be slightly negative. A positive effect is expected on traditional fishing in the vicinity. In principle no significant negative impact is expected on the surveillance of or communication with shipping traffic due to the presence and exploitation of the wind farms. A collision/drifting could cause a leak in a cargo tank or bunker tank resulting in an outflow of cargo oil or bunker oil. These effects can be limited and controlled if the necessary intervention plans and procedures are available.

The effects during the *dismantling phase* will be similar to those during the installation phase. The effects depend on whether the foundation (or part of it) and the erosion protection are removed. The choice whether or not to remove the erosion protection and the foundation is best made at the end of the exploitation and based on the available experience, technology and monitoring results.

The main effect of the cable installation is the local disturbance of the seabed and the animal life in it. The impact will be limited to the immediate vicinity of the cable routes and disappear after a time (small negative effect). Not much is known about the influence of electromagnetic radiation and the local warming of the seabed (due to the heat formation of the electric cables) on fish and benthic organisms during the exploitation of the wind farm but it will be restricted to the near vicinity.

There can be concluded that the effects during construction, exploitation and dismantling will be all in the range of acceptable for both the original and enlarged concession area and that in no case it is a matter of significant negative effects (in relation to the BPNS).

In view of the position and distance of the installation in relation to neighbouring countries some limited negative border crossing effects can be expected concerning the Netherlands, for the original as well as the enlarged concession area. Of all the disciplines that were considered, only a limited negative effect can perhaps be expected for the disciplines of noise, sea view and safety. As a result of the large distance to the Dutch coast, the effects (noise, seascape) will be negligible.

For the cumulative effects (effects of the three wind farms combined) only those effects are discussed that are non-negligible for a single wind farm. For these non-negligible effects, the cumulative effect will usually be equal or smaller than the sum of the individual effects. In general, the cumulative effects will not change if a change (original concession area) or an extension (enlarged concession area) is chosen by Eldepasco.

In total (all 3 wind farms) almost 7.6 million m³ (original concession area Eldepasco) to 8.7 million m³ (enlarged concession area Eldepasco) of sand will be laid up in the respective concession areas as a result of the excavation required if each of the projects were to opt for gravity foundations (worst case) for all wind turbines, which is highly unlikely. The cumulative effect of the laying up of sand will, due to phasing of the activities, be smaller than the sum of the effects. The prevented emissions of each wind farm on its own already means a considerable contribution to the targets set for Belgium for the reduction of SO_2, NOx and CO_2. The cumulative contribution will obviously be even greater and is equivalent to the sum of the individual contributions. During the exploitation, the underwater noise of the wind turbines is limited to the safety zone; the cumulative effect is therefore equal to the sum of the individual effects. For the majority of the effects on benthos and fish, the cumulative effect is the sum of the separate effects – often directly proportional to the space occupied, which in reality is relatively small in relation to the BPNS - per wind farm. For birds and sea mammals the cumulative effect is the sum of the separate effects too. Only as regards the loss of habitat for resting and foraging birds by the impact of each wind farm, there is a cumulative effect that is greater than the sum of the effects per wind farm. Here the cumulative effect on the disturbance of Razorbills, Guillemots and Gannets is judged to be moderately negative. No negative cumulative effects worth mentioning are anticipated for the various users of the North Sea. For the three wind farms, 774-846 MW of installed power altogether, a collision or floating collision with a wind turbine on one of the three wind farms is expected to occur between once every 9 years (Marin, 2007) or 23 years (DNV, 2008), whereby this can be expected to lead to an outflow of cargo oil or bunker oil once every 227 years respectively 125 years. This has been evaluated as an acceptable risk. In principle, no significant negative impact is expected from the presence and exploitation of the 3 wind farms on the surveillance of or communication with shipping traffic.