3 Physical Environment (Offshore)

3.1 Hydrodynamic, Sedimentary and Coastal Processes

3.1.1 Baseline Information

Introduction

3.1.1.1 This chapter considers the likely significant effects of the modified offshore transmission infrastructure (modified OfTI) on the marine physical environment and draws upon the technical assessments previously undertaken for the MORL ES (MORL, 2012). A more detailed description of the methodologies and analyses used may be found in the supporting technical appendix: Metocean and Coastal Processes (Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes).

3.1.1.2 This section provides a summary characterisation of the marine physical environment in the vicinity of the modified OfTI. This includes:

- Bathymetry;
- Wind Climate;
- Hydrodynamics (Tidal Regime, Wave Climate and Stratification);
- Geology; and
- Sedimentary Processes.

3.1.1.3 A more detailed description may be found in the supporting technical appendix (Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes).

3.1.1.4 This baseline characterisation is used to inform the impact assessments that follow.

3.1.1.5 This baseline and the associated impact assessments are also used to inform the following assessments:

- Benthic Ecology (Chapter 4.1);
- Fish and Shellfish Ecology (Chapter 4.2); and
- Archaeology and Visual Receptors (Chapter 5.4).

3.1.1.6 This baseline section also includes relevant details including the following:

- Consultation with relevant statutory bodies;
- Detailed desk study and accompanying field survey to establish baseline conditions; and
- Consideration of the relevant key legislative and planning information.

Consultations

3.1.1.7 During the scoping consultations (described in more detail in Chapter 1.4 of this ES), methodologies and data sources were proposed to inform the baseline understanding of the hydrodynamic and sedimentary environments. The suggested methods included the use of previously collected and new field data, numerical modelling, desktop assessments and reference to previous studies.

3.1.1.8 Table 3.1-1 below summarises specific comments made during the 2014 scoping process. No specific comments were made regarding the development of a physical environment baseline. The baseline information provided in Section 3.1.1 and the impact assessments provided in Sections 3.1.2 and 3.1.3 below address the component issues and concerns outlined in the Table 3.1-1. Full details of all scoping responses are provided in Chapter 1, section 1.4 of this ES.

Table 3.1-1 Physical Process Issues and Concerns Expressed During the 2014 Scoping Process

Organisation	Consultation Response	MORL Approach
SNH/JNCC	[SNH/ JNCC] agree with the aspects 'scoped in' and 'scoped out' for the offshore assessment as set out [in the scoping report]. [SNH/ JNCC] consider it appropriate to focus attention on the two geological Sites of Special Scientific Interest ("SSSI") in the area – Cullen to Stake Ness Coast SSSI and Whitehills to Melrose Coast SSSI – adjacent to each of the potential landfall options at Sandend Bay and Boyndie Bay.	Impacts have been assessed as per the "scoped in" list. The two geological sites have been included in the impact assessments.
Aberdeenshire Council	Aberdeenshire Council request that consideration be given to the geological interests of Cullen to Stake Ness Coast SSSI and Whitehills to Melrose Coast SSSI. Aberdeenshire Council consider it appropriate that the potential effects of sea level rise (amongst other climate change variables) should be considered within the planning of the development (known as 'future-proofing'), particularly in respect of the cable landfall. Aberdeenshire Council state that the scoping report does not indicate whether impacts to the geological interest along this coast can be avoided or what mitigation is proposed. These should be addressed in the EIA. Aberdeenshire Council agree with the aspects 'scoped in' and 'scoped out' for the offshore assessment as set out in the scoping report. Aspects to be scoped in include: damage to geological features/designated sites.	As above.

Baseline Characteristics

3.1.1.9 The physical environment baseline characteristics of the modified OfTI corridor are summarised below, using a combination of the information collated and analysed via desktop studies and site specific surveys (Sections 3.1.1.41-3.1.1.48). The study area is shown in Figure 3.1-1.

Bathymetry

3.1.1.10 Water depths along the modified OfTI corridor are highly variable ranging from <10 m mean sea level (msl) in the shallow inshore area adjacent to the Banffshire coast to approximately 80 m msl in the Southern Trench, a long deep channel located in the southern part of the outer Moray Firth. The Southern Trench reaches depths of approximately 220 m msl off the Aberdeenshire coast to the east of the modified offshore export cable route corridor. Within the three consented wind farm sites, water depths are typically in the range 35 to 55 m msl, with depths increasing from west to east.

Water Levels

3.1.1.11 The modified OfTI is subject to semi-diurnal tidal variations in water level, with a mean spring range of approximately 3 m.

3.1.1.12 Storm surges may cause short term modification to predicted water levels and under an extreme (1 in 50-year return period) storm surge, water levels may be up to 1.25 m above predicted levels.

3.1.1.13 It is probable that relative sea levels will rise in this region during the course of the 21st Century and by 2050 is likely to be approximately 0.22 and 0.35 m higher than 1990 levels.

3.1.1.14 Climate change may be expected to slightly increase the mean water level over the lifetime of the modified OfTI; however, the tidal range about the new mean level is not likely to be measurably affected.

Currents

3.1.1.15 Depth-averaged peak spring current speeds range between approximately 0.2-0.5 m/s across the area covered by the modified OfTI, with the fastest speeds recorded along the northern margin of Telford wind farm. Within the consented wind farm sites, peak flood current speeds are approximately 10% faster than adjacent peak ebb current speeds due to the influence of the Pentland Firth. Relatively weaker currents are encountered along the modified offshore export cable route corridor.

3.1.1.16 Peak flood currents (directed approximately south or south south west into the Moray Firth) occur approximately 1.5 to 2 hours before high water at Wick; peak ebb currents (directed approximately north or north north east out of the Moray Firth) occur approximately 4 to 4.5 hours after high water at Wick. The exact phasing of individual tides varies slightly due the higher harmonics affecting tidal water levels in the region (causing consecutive high and low waters to modulate in height and range with a corresponding effect on peak current speed). Residual tidal currents (over a period of days to weeks) are directed south west or south south west into the Moray Firth.

3.1.1.17 Spring tidal excursion ellipses (which show the approximate path that a package of water would follow over the course of a mean spring tide) are quite strongly rectilinear near the coast and along the northern margin of Telford wind farm. At the coast, the major axes of the ellipses extend approximately 5 km in an east-southeast to west-northwest direction whereas within the consented wind farm sites the major axes are more typically orientated in a general north to south direction. Along much of the modified offshore export cable route corridor the spring tidal excursion ellipses are generally rotary in nature.

3.1.1.18 During an extreme (1 in 50-year return period) storm surge, current speeds may be more than twice that encountered under normal peak spring tide conditions along the modified offshore export cable route corridor.

3.1.1.19 Climate change is not expected to have any effect on the local tidal current regime (currents are largely controlled by the corresponding tidal range) over the lifetime of the modified OfTI.

Wind Climate

3.1.1.20 The prevailing wind direction is from the WSW, SW and W (225 to 270 ˚N), accounting for almost 30% of the record, and from the SSE, SE and ESE (157.5 to 112.5 ˚N), accounting for around 20% of the record. Wind speeds are in the range 2 to 15 m/s over 80% of the time. During extreme events (return period of one in ten years or more), wind speeds might peak as high as 30 or 35 m/s.

Waves

3.1.1.21 The wave regime in the outer Moray Firth includes both swell waves generated elsewhere in the North Sea and locally generated wind waves. The wave regime in the outer Moray Firth is typically characterised by fetch limited wave conditions (from the west and south-west). Longer period swell waves tend to come from offshore sectors only.

3.1.1.22 The largest waves come from the more exposed offshore sectors (from north through south east) although the southern end of the modified offshore export cable route corridor is sheltered from south-easterly waves. Offshore wave heights during extreme events from these directional sectors may be 6-7 m during relatively frequent (annual) events or as much as 9 m for the 50 year return period condition. However, waves coming from other directions within the Moray Firth are generally smaller during extreme events (4-5 m or up to 7 m, respectively) due to the relatively shorter distances available for wave growth.

3.1.1.23 The variable water depths along the modified offshore export cable route corridor mean that the ability of a given wave condition to exert influence on the seabed may also be variable. However, even in those areas where water depths exceed 30 m, storm waves sufficiently large to cause water motion at the seabed are not uncommon.

3.1.1.24 During a 1:1 year storm event, orbital currents are likely to approach 1 m/s at the northern end of the modified offshore export cable route corridor, in the relatively shallow (i.e. ~35 m msl) water over the crest of the Smith Bank. In the shallow (i.e. <20 m msl) water adjacent to the Banffshire coast, these wave induced orbital currents are expected to be even higher. Currents of this magnitude are considerably greater than tidal currents observed during peak spring tidal flows.

3.1.1.25 Climate change may cause variability in the inter-annual wave climate over the lifetime of the modified OfTI; however, no clear trends are apparent from inspection of available historical records.

Stratification

3.1.1.26 Stratification occurs in the coastal seas due to seasonal heating of the water and vertical fronts can develop between regions of freshwater influence. Previously published papers (e.g. Adams and Martin, 1986; Connor *et al*., 2006) were used to characterise stratification and fronts including their general location and characteristics in relation to primary productivity. The Buchan front is a relatively weak front located in the outer Moray Firth.

3.1.1.27 Applying general oceanographic theory, it is likely that the weak strength and natural position of the Buchan front in the outer Moray Firth is governed by the relative magnitude of tidal current flows in the adjacent inshore areas and of seasonal stratification in adjacent offshore areas.

3.1.1.28 Climate change is not expected to have any effect on the range of natural variability in the location or strength of stratification and fronts over the lifetime of the modified OfTI.

Geology

3.1.1.29 The offshore near-surface geology in the outer Moray Firth is composed predominantly of Cretaceous rocks whilst both Jurassic and Permo-Triassic rocks are encountered along the southern / inner margins of the Firth. An extensive blanket of Quaternary deposits is present across almost the entire Firth with sediment thicknesses of around 70 m commonly observed.

3.1.1.30 The Smith Bank (at the northern end of the modified offshore export cable route corridor) is a geologically constrained feature, i.e. it is a raised hard rock feature, overlain by a relatively thin veneer of more recently deposited marine sediments. The nature of these surficial marine sediments is described in the following section.

3.1.1.31 The Southern Trench (which is located between the Banffshire Coast and the three consented wind farm sites) is an enclosed deep that cuts through both Quaternary deposits and the underlying bedrock. The exact origin of the trench is unknown although may have been driven by different processes of fluvial and / or ice marginal erosion during the Quaternary period (Brooks *et al*., 2012).

Sedimentary Processes

3.1.1.32 Seabed sediments along the modified offshore export cable route corridor are variable, reflecting variability in both the prevailing hydrodynamic conditions and underlying geology. At both the northern end of the modified offshore export cable route corridor and in the vicinity of the landfall, seabed sediments generally consist of gravelly sands and sandy gravel; fine (silt and clay sized) particles are largely absent.

3.1.1.33 However, seabed sediments become progressively finer in deeper water along modified offshore export cable route corridor, becoming relatively muddy (i.e. Sand mud and Muddy sand) in the deepest parts, at the western end of the Southern Trench. The sediment character and distribution in these offshore sections is the result of the relatively benign tidal regime and the spatially variable effect of wave action at the seabed, depending upon the local water depth.

3.1.1.34 Along much of the modified offshore export cable route corridor, surficial marine sediments are generally thin (1-3 m) with the underlying glacial till very close to the surface.

3.1.1.35 Across almost the entire Moray Firth an extensive blanket of Quaternary deposits (glacial tills) are present below the marine sand veneer. The thickness of this layer is commonly observed to be in excess of 100 m although is found to be less than 20 m in the vicinity of the wind farms. These sediments are underlain by a thick unit of firm to very hard Lower Cretaceous clay.

3.1.1.36 The available evidence suggests that (bedload) material is travelling into the Firth from the north, passing along the Caithness coast and towards the inner Moray Firth. In this region, tidal currents are largely incapable of mobilising anything larger than fine sand-sized and as a result, there is only limited net bedload transport of sediment due to tidal currents alone.

3.1.1.37 However, in shallower areas (i.e. less than 30 m msl) the combination of tidal and non-tidal currents and wave induced currents during storms results in considerably higher current speeds at the bed. As a result, it is likely that the commonly present medium-sized sand is regularly mobilised during storms.

3.1.1.38 During calm conditions, suspended sediment concentrations are typically very low (approximately < 5 mg/l). However, during storm events, near bed current speeds can be markedly increased due to the influence of waves stirring of the seabed. This can cause a short-term increase in suspended sediment concentration, theoretically in the order of 1,000s to 10,000s of mg/l very close to the seabed, 100s or 1,000s mg/l in the lower water column but only 10s of mg/l in the upper water column. Coarser sediments may be transported a short distance in the direction of ambient flow or down-slope under gravity before being re-deposited. Finer material that persists in suspension will eventually be transported in the direction of net tidal residual flow.

3.1.1.39 The coastline at the landfall site is generally characterised as a sandy pocket embayment. The beach is sandy with a shallow gradient and is backed by a mixture of coastal defences, managed ground and mature vegetated sandy dunes. The beach is constrained by rocky headlands and underpinned by a bedrock platform.

3.1.1.40 Climate change is not expected to have any effect on the type or distribution of sediments within the extent of and over the lifetime of the modified OfTI.

Desktop Studies

3.1.1.41 In order to characterise the physical environment along and in the vicinity of the modified offshore export cable route corridor, various publically available data sources were used. These included:

- Digital bathymetry data sets and publications from the UK Hydrographic Office (UKHO);
- Primary tide gauge data for the Moray Firth (available from the National Tide and Sea level Facility and UKHO);
- Extreme storm surge predictions from the Proudman Oceanographic laboratory (POL);
- Charted data from the British Geological Survey (BGS 1984, 1987);
- Previously collected seabed grab data (British Geological Survey, BGS); and
- Projections of future climate change available from UKCP09 (Lowe *et al*., 2009).

3.1.1.42 Further to the additional data sets acquired, a number of key reports have also been used which hold direct relevance to the modified OfTI. These include, but are not limited to:

- Coastal Cells in Scotland: Cell 3 - Cairnbulg Point to Duncansby Head (Ramsay & Brampton, 2000);
- JNCC Coastal Directory Series: Regional Report 3 North East Scotland; Cape Wrath to St Cyrus (Barne *et al*., 1996);
- Offshore Energy Strategic Environmental Assessment -- SEA 2 (DECC, 2011b); SEA 5 (Balson *et al*., 2001; Holmes *et al*., 2004);
- Sand banks, sand transport and offshore wind farms (Kenyon & Cooper, 2005);
- The Beaches of Northeast Scotland (Ritchie, Rose & Smith, 1979).
- The Beaches of Scotland (Ritchie & Mather, 1984); and
- United Kingdom Offshore Regional Reports Series: The Moray Firth (Andrews *et al*., 1990).

3.1.1.43 Observed data are inherently limited either in temporal or spatial resolution and extent. To reduce any residual uncertainties and to provide additional data for the MORL ES (MORL, 2012), numerical tidal and wave models were created. Full details of the numerical modelling tools used may be found in the MORL ES (MORL, 2012, Appendix 3.4 B).

Site Specific Surveys

3.1.1.44 The following surveys were undertaken by MORL in order to provide primary site specific data to the original Project. These data have been used in conjunction with other secondary data and literature (outlined in the above) to inform the baseline characterisation and impact assessments within the area of the modified OfTI.

3.1.1.45 One wave buoy and three seabed frames (collecting wave, current, water level and suspended sediment information) were deployed at strategic locations within the three consented wind farm sites by Partrac (MORL, 2012, Appendix 3.4 A: Metocean and Coastal Processes Baseline).

3.1.1.46 A seismic survey of sub-bottom geology in the wind farm sites was undertaken between May and September 2010 and is reported in MORL (2012, Appendix 3.4 A: Metocean and Coastal Processes Baseline).

3.1.1.47 An additional high resolution swath bathymetry survey, side scan sonar survey and seismic survey of sub-bottom geology within the modified OfTI corridor was undertaken in May and June 2014.

3.1.1.48 Sixty nine grab samples of surficial seabed sediments were collected within the three consented wind farm sites as part of the benthic ecology survey and reported in MORL (2012, Technical Appendix 4.2 A: Benthic Ecology Characterisation Study (Wind Farm Sites). A further eleven grab samples of surficial seabed sediments were collected along the modified OfTI export cable corridor in 2014 as part of the benthic ecology survey and are described fully in Technical Appendix 4.1 A: Subtidal Ecology Characterisation of this ES.

Legislative and Planning Framework

3.1.1.49 Legislative and planning frameworks do not provide specific requirements in relation to the baseline understanding of hydrodynamic, sedimentary and coastal processes. An understanding of the baseline environment is of course expected.

3.1.1.50 The methods used are however consistent with the guidelines for data collection in support of offshore wind farm environmental impact assessment provided by: Cefas (2004, 2011); COWRIE (2009) and EMEC & Xodus AURORA (2010).

3.1.2 Impact Assessment

Summary of Effects and Mitigation

3.1.2.1 This section considers the likely significant effects of the modified OfTI on the physical hydrodynamic environment (the tidal and wave regimes) and the physical sedimentary environment (patterns of sediment transport and geomorphological evolution). This assessment is informed by the baseline information described in Section 3.1.1 and Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes.

3.1.2.2 This impact assessment is also used to inform the following assessments:

- Benthic Ecology (Chapter 4.1);
- Fish and Shellfish Ecology (Chapter 4.2); and
- Archaeology and Visual Receptors (Chapter 5.4).

3.1.2.3 The effects that were assessed are:

- Changes to the tidal regime due to the presence of the offshore export cable and offshore platforms (OSP);
- Changes to the wave regime due to the presence of the offshore export cable and OSPs;
- Increase in suspended sediment concentrations as a result of OSP installation activities and the presence of the OSP foundations;
- Increase in suspended sediment concentrations as a result of export cable installation activities;
- Disturbance of coastal morphology at the proposed landfall sites; and
- Scour effects due to the presence of the OSP foundations, export cables and cable protection measures.

Summary of Impacts

3.1.2.4 Receptors considered in this assessment are:

- The Smith Bank;
- Seabed within the offshore export cable route corridor;
- Designated Coastal Habitats;
- Recreational Surfing Venues; and
- Coastal morphology at the export cable landfall.

3.1.2.5 Receptors scoped into the assessment were identified on the basis of:

- Comments received during the scoping stage;
- Guidance on the assessment of marine physical processes for renewable energy developments (Technical Appendix 3.1 A: Hydrodynamic, Sedimentary and Physical Processes); and
- Understanding of the likely spatial and temporal scale of effects (this was informed in part by the findings presented in the MORL ES (2012)).

3.1.2.6 All impacts associated with hydrodynamic, sedimentary and coastal process related receptors were found to be of either negligible significance or minor significance.

Summary of Proposed Mitigation Measures and Residual Effects

3.1.2.7 Scour protection for cables and OSP foundations is proposed where required to prevent scour.

3.1.2.8 Table 3.1-2 below summarises the results of the impact assessment.

Table 3.1-2 Impact Assessment Summary

Effect	**Receptor**	**Pre-mitigation Effect**	**Mitigation**	**Post-Mitigation Effect**
Construction/Decommissioning				
Changes to the tidal and wave regimes (Cables)	The Smith Bank, Designated Sites and Recreational Surfing Beaches	Negligible Significance	None	Negligible Significance

Effect	Receptor	Pre-mitigation Effect	Mitigation	Post-Mitigation Effect
Increase in suspended sediment concentrations and changes in sediment type/thickness at the seabed as a result of export cable installation activities	The Smith Bank & seabed along the modified OfTI corridor	Minor Significance	None	Minor Significance
Increase in suspended sediment concentrations and changes in sediment type/thickness at the seabed as a result of OSP installation activities	The Smith Bank	Minor Significance	None	Minor Significance
Disturbance of coastal morphology at the landfall site	Inverboyndie Landfall, seabed along the cable corridor and SSSIs	Negligible Significance	None	Negligible Significance
Operation				
Changes to the tidal and wave regimes (Cables)	The Smith Bank, Designated Sites and Recreational Surfing Beaches	Negligible Significance	None	Negligible Significance
Changes to the tidal and wave regimes (OSPs)	The Smith Bank, Designated Sites and Recreational Surfing Beaches	Negligible Significance	None	Negligible Significance
Changes to the sediment transport regime due to the presence of the OSP foundations	The Smith Bank	Negligible Significance	None	Negligible Significance
	Designated Coastal Habitats	Minor Significance	None	Minor Significance
Scour effects due to the presence of the OSP foundations	The Smith Bank	Minor Significance	Scour protection	Negligible Significance
Scour effects due to the exposure of export cables	The Smith Bank & seabed along the modified OfTI corridor	Negligible Significance	Scour protection	Negligible Significance
Scour effects due to cable protection measures	The Smith Bank & seabed along the modified OfTI corridor	Negligible Significance	None	Negligible Significance
Decommissioning				
(Partial impacts only)	As 'Construction'	Negligible or Minor Significance	None	Negligible or Minor Significance

Introduction to Impact Assessment

3.1.2.9 This section describes the likely significant effects of the modified OfTI on physical processes in the marine environment and includes effects on water levels, currents, waves, sediment transport and geomorphology.

3.1.2.10 The baseline wave, tidal and sedimentary conditions are described above in Section 3.1.1 of this document and in the supporting Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes.

Details of Impact Assessment

3.1.2.11 This assessment considers the effects of the modified OfTI on physical process receptors identified within and nearby to the area covered by the modified OfTI. Physical process receptors that are potentially sensitive to changes in the physical baseline environment include:

- The Smith Bank – A submerged bathymetric high (30-50 m deep) in the outer Moray Firth with a core of stable glacial tills covered by a veneer of sands and gravels of variable thickness and proportion. The form and function of the bank is relatively insensitive to changes in physical processes but is considered due to its proximity to the source of effects from the modified OfTI and wind farm infrastructure.
- Seabed within the modified offshore export cable route corridor – generally deeper than the Smith Bank (50-100 m along most of its length, shoaling towards the landfall). Predominantly sandy with gravel and mud in varying proportions. The proportion of mud generally increases in central parts of the Moray Firth and in deeper water. Sediments become coarser gravels offshore of the landfall. Sediments are sandy again within Inverboyndie Bay. The seabed along the modified offshore export cable route corridor is not subject to any special designations.
- Designated sites - SPA, SAC, SSSI and Ramsar sites on the Moray Firth coastline. A full list of the sites considered and a summary of their morphological type may be found in Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes. These receptors are potentially sensitive to local changes in tidal range, wave climate and sediment supply.
- Recreational surfing venues - A full list of the sites considered and a summary of their baseline wave characteristics may be found in the Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes. These receptors are variably sensitive to local changes in tidal range and wave climate.
- Inverboyndie landfall site - A sandy beach within an embayment bounded by rocky headlands. The beach at the landfall is backed by low coastal protection and the hinterland is both managed and vegetated. The local landfall site is surrounded by, but not part of, the Whitehills to Melrose Coast SSSI.

3.1.2.12 A change in tidal or wave regimes alone does not necessarily imply an effect if there are no receptors present which are sensitive to the change. Consequential (indirect) effects on sediment transport patterns and morphology are also considered.

3.1.2.13 Effects on these receptors are considered in relation to the construction, operation and decommissioning phases of the development.

Rochdale Envelope Parameters Considered in the Assessment

3.1.2.14 The range of parameters adopted within this physical process assessment are summarised in Table 3.1-3 below. The parameters set out below define the "Rochdale Envelope" realistic worst case scenario for each likely significant effect on the physical environment offshore. These are drawn from a range of development options set out in the project description in Chapter 2.2 (Project Description).

Table 3.1-3 Rochdale Envelope Parameters Relevant to the Impact Assessment

Type of Effect	Rochdale Envelope Scenario Assessed
Construction & Decommissioning	
Changes to the tidal and wave regimes	Up to four cables with a 0.25 m diameter, initially laid to the seabed, then buried or otherwise protected for their operational lifetime.
Increase in suspended sediment concentrations as a result of offshore export cable installation activities	Up to four parallel cable trenches excavated by energetic means (e.g. jetting). Single trench (i.e. multiple export cable trenches not simultaneously installed) with cross-section of disturbance 3 m wide by 3 m deep in 'V' shaped profile. 100% of material resuspended.
Increase in suspended sediment concentrations as a result of OSP foundation installation activities	Two OSPs. Foundation type assessed – jack-up.
Disturbance of coastal morphology at the landfall site	Open trenching or horizontal directional drilling (HDD) at the proposed landfall location.
Operation	
Changes to the tidal and wave regimes	Cables 0.25 m diameter, buried or otherwise protected for their operational lifetime.
	Two OSPs. Foundation type assessed – jacket.
Changes to the sediment transport regime due to the presence of the OSP foundations	Two OSPs. Foundation type assessed – jack-up.
Scour effects due to the presence of the OSP foundations	
Scour effects due to the exposure of transmission cables and due to cable protection measures	Offshore export cables and cable protection measures.

OSP Foundations

3.1.2.15 As part of the modified OfTI, a maximum of two OSPs will be installed within the MORL Zone. The final locations of these two OSP structures have not yet been established, but do not influence the overall outcome of the assessments due to their relatively small scale when compared to the offshore wind farm infrastructure.

3.1.2.16 OSPs may utilise a jacket or jack-up foundation type, both of which are similarly characterised as a lattice structure. Of these, the jacket is considered to have the greatest relative cross-sectional area and blockage effect. The base will be square in cross-section. The jack-up has the most number of pin-piles as it will be fixed to the seabed at the end of each primary member using up to four pin piles.

Installation Methods for OSP Pin Piles

3.1.2.17 Each pinned jack-up type OSP foundation requires up to 16 pin piles to be inserted into the seabed. The most efficient and preferred method for installation is to simply drive (hammer) each pile in turn to the required depth. In some circumstances the soil conditions along some or all of the profile may pose too much resistance for driving alone and a pilot hole must be drilled ahead of the pile (a drill-drive methodology). The drill arisings (cuttings) will then be released directly into the water column, or captured into a hopper and subsequently disposed of in a controlled manner.

3.1.2.18 Up to sixteen pin piles of 3 m diameter will be consecutively installed at each foundation (worst case a 3 m diameter hole, 60 m deep). It is assumed to take 12 hours to drill one pile, a drilling rate of 0.00139 m/s, releasing 0.00982 m^3/s or 26 kg/s of arisings. An allowance of 3 hours is made for repositioning between piles and 12 hours between foundations. These assumptions are the same as previously used in the MORL ES (MORL, 2012).

3.1.2.19 The geophysical survey data (collected in 2010) shows that the eastern part of the Moray Firth Round 3 Zone is generally characterised by a marine sand layer overlying a more consolidated till. The marine sand comprises, on average, 83 % sand, 8 % silt and 9 % clay material. The underlying till comprises, on average, 50 % sand, 20 % silt and 30 % clay material. The thickness of these layers has been determined, at each foundation location, using the subsurface geophysical data. The proportion of each sediment fraction being released is adjusted in time, according to the thickness of the marine sand layer and the drilling rate.

3.1.2.20 In the present study, the worst case assumption is that all sediments arise as a fully fluidised mixture. In practice, the nature of the arisings may vary considerably depending upon the exact geotechnical nature of the sub-soils and the drill head used. Also, arisings may consist of larger chunks which will be very differently transported and (locally) deposited.

3.1.2.21 Suction caissons are the alternative to pin piles for the jacket foundation type. Suction caissons are installed to a shallower depth without drilling and so are not expected to disturb the seabed sediments or, therefore, place sediment into suspension.

Scour Protection

3.1.2.22 The risk of scour destabilising or undermining marine structures is often mitigated by the use of scour protection. This may take various forms including: rock placement or gravel filter layers; geo-textile or frond matting; and concrete mattresses.

3.1.2.23 Scour protection is to be used in conjunction with all OSP foundation options. Scour protection for foundations will extend between 10 and 20 m from the edge of the structure for pin piled and suction caisson options, respectively. Scour protection for exposed cables will typically extend in the order of a few metres either side of the export cable location.

3.1.2.24 In the present study, the worst case assumption used is that there will be a sufficient window of time between installation of the foundation and the application of scour protection, which would allow the maximum possible dimensions of scour to develop.

Number and Length of Export Cables

3.1.2.25 The OfTI export cable route corridor is shown in Figure 3.1-1 and makes landfall in the vicinity of Inverboyndie. Up to four parallel cable trenches will be installed within the export cable corridor, each containing one cable. The cables and trenches will be separated by tens or hundreds of metres, depending on the water depth, and will not be installed simultaneously.

3.1.2.26 Should two substations be required, approximately 70 km of export and inter-platform cables will also be installed within the three consented wind farms.

3.1.2.27 The export cable diameter will be in the order of 0.25 m. Due to their necessary metal content and construction, the cables are relatively heavy (order of tens of kilograms per metre of length) and therefore unlikely to be moved directly by waves or currents once laid.

Offshore Export Cable Burial Methodology

3.1.2.28 The local geology and geomorphology of the seabed will determine the cable installation method used (Royal Haskoning and BOMEL, 2008). The proposed methods of cable installation generically include:

- Ploughing;
- Jetting; and
- Mechanical cutting tools.

3.1.2.29 Where seabed conditions do not allow for cable burial, concrete mattress or rock placement might be used to cover and protect surface laid cables.

3.1.2.30 The available information indicates that the majority of offshore wind farms use either ploughing or jetting methods to install cables.

3.1.2.31 Consistent with the proposed design and the evidence and case studies provided in Royal Haskoning and BOMEL (2008), the realistic worst case cable installation parameters are:

- The trench has a 'V' shaped profile 3 m wide at the surface and up to 3 m deep (1 m is the target depth);
- 100 % of sediment volume in the trench may be resuspended by any method;
- The material will likely arise as chunks but worst case assumption is that all sediments are fluidised as a fine suspension; and
- Cables will be separately (not simultaneously) installed.

Offshore Export Cable Landfall Methodology

3.1.2.32 The cable landfall is at Inverboyndie on the south coast of the Moray Firth. Inverboyndie Beach is a pocket embayment, enclosed by rocky headlands and with a sandy veneer overlying a rock platform. A more detailed description of this location is given in Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes.

3.1.2.33 The rocky coastal exposures surrounding Inverboyndie are designated as the Whitehills to Melrose Coast Site of Special Scientific Interest (SSSI). The designated feature is the 'structural and metamorphic geology', i.e. the accessibility, visibility and integrity of the rocky outcrops that are present on the exposed coastline. However, the natural absence of visible exposures on the sandy beach and hinterland at Inverboyndie mean that the landfall locality is not subject to the same designation.

3.1.2.34 The most likely cable landfall options are:

- The cable will be laid into a trench cut downwards into the beach surface and subsequently buried by backfilling the trench; or,

- A Horizontal Directional Drill (HDD) will be used to create an underground conduit for the cables, from a point onshore behind the beach, to a point offshore. The drilling will be initiated from the onshore end of the route and all drill arisings will be collected there.

EIA Methodology

3.1.2.35 The methodology and terminology for the assessment of significance of any impacts is the same as that described in the MORL ES (MORL, 2012, Section 6.1: Hydrodynamics (Wave Climate and Tidal Regime)) in relation to the wind farm infrastructure.

3.1.2.36 The significance of the potential impacts on the identified coastal process receptors (described in (Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes) has been assessed using the following method and terminology.

3.1.2.37 Firstly, the magnitude of any impacts has been quantified to the extent practicable, considering all the dimensions of the predicted impact including:

- The nature of the change (i.e. what resources or receptors are affected and the size, scale or intensity of any changes);
- The spatial extent or proportion of the area impacted;
- The temporal extent of the impacts (i.e. duration, frequency, reversibility); and
- Where relevant, the probability of the impact occurring as a result of accidental or unplanned events.

3.1.2.38 The magnitude of the impact has been considered in relation to the following spatial and temporal scales.

3.1.2.39 Spatial Scales:

- Onsite – impacts that are limited to the wind farm area or cable corridor (i.e. the near-field study area);
- Local – impacts that are limited to the wind farm area or cable corridor and generally within the area of one tidal excursion (or a similar 'buffer' around the areas);
- Regional – impacts that are experienced at a regional scale e.g. the Moray Firth;
- National – impacts that are experienced at a national scale; and
- Transboundary / International – impacts that are experienced at an international scale i.e. affecting another country or international water.

3.1.2.40 Temporal Scales:

- Short-term – impacts that are predicted to last only for the duration of specific construction operations e.g. noise for piling and plume dispersion;
- Medium-term – impacts that are predicted to last during the construction period (e.g. 1-3 years);
- Long-term – impacts that will continue beyond the construction period but will cease in time (e.g. recovery of benthos, vessel movements);
- Temporary – impacts that are predicted to be reversible and will return to a previous state when the impact ceases or after a period of recovery;
- Permanent – impacts that cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime;

- Continuous – impacts that occur continuously or frequently; and
- Intermittent – impacts that are occasional or occur only under specific circumstances.

3.1.2.41 Secondly, the importance, value and/or sensitivity of the impacted receptors or sites has been estimated. In the context of physical processes and in this report, the sensitivity of the impacted physical environment will be evaluated in the context of the natural range of variability normally experienced in the parameter of interest. Further assignment of value or significance (e.g. to the consequential impact on ecological or socio-economic receptors) will be subsequently provided by other topic assessments.

3.1.2.42 Thirdly, the significance of an impact of a given magnitude has been determined on the basis of the magnitude and sensitivity as follows:

- Negligible significance. Impacts that are slight or transitory, and those that are within the range of natural environmental variability;
- Minor significance. Impacts of small magnitude and /or associated with low or medium value / sensitivity receptors or sites, or impacts of medium magnitude affecting low value / sensitivity receptors or sites;
- Moderate significance. Impacts of small magnitude, affecting high value / sensitivity receptors or sites, or impacts of medium magnitude affecting medium value / sensitivity receptors or sites, or impacts of large magnitude affecting medium sensitivity receptors or sites; and
- Major significance. Impacts of large magnitude affecting high or medium value / sensitivity receptors or sites, or impacts of medium magnitude affecting high value / sensitivity receptors or sites.

3.1.2.43 Impacts of negligible and minor significance are considered to be not significant in relation to the present EIA regulations.

Impact Assessment

Construction

Changes to the Tidal and Wave Regimes (Transmission Cables)

3.1.2.44 Changes to the tidal and wave regimes as a consequence of the OSPs will be greatest once all the OSPs have been fully installed, i.e. during the operational phase. Any effects during the construction phase will be subordinate to those experienced during the operation phase and therefore have not been considered in this section.

3.1.2.45 Cables will be laid onto the seabed through the water column. It is intended to then bury the cables along most of their length. Where cable burial is not possible, cables will remain surface laid under cable protection measures (rock placement or mattressing). Introducing these materials and machines to the baseline environment will present some small blockage to water movements locally.

<u>Sensitive Receptor: The Smith Bank, Designated Sites and Recreational Surfing Venues</u>

3.1.2.46 The diameter of the transmission cables (order of 0.25 m) is too small to modify the ambient currents other than locally (to a distance of no more than the order of tens of centimetres from the cable) and only then when and where it is both submerged in the water and exposed above the seabed (as may happen during the construction period). As such, if the cable is laid and buried in one continuous operation, these effects will last for the order of seconds or minutes locally and would be small in comparison to the (also relatively small) disturbance associated with the presence and passage of the cable burial machine. If the cable is laid initially onto the seabed surface and buried more than a few hours later, more persistent but still small magnitude change to local currents may lead to local scour.

3.1.2.47 The diameter of the transmission cables is also too small to modify the ambient wave regime (height, period, direction). The cable may however interact locally with the oscillatory water motion under individual waves as described in the previous paragraph in relation to tidal currents, if the waves present are sufficiently large to cause movement of water at the seabed.

3.1.2.48 A negligible magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.49 The nature, magnitude, sensitivity and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

Increase in Suspended Sediment Concentrations (SSC) and Changes in Sediment Type/Thickness at the Seabed as a Result of Offshore Export Cable Installation Activities

3.1.2.50 An increase in SSC will arise where sediments are disturbed during energetic operations at or below the seabed. The magnitude of the effect locally will depend upon the sediment release rate. The nature of the effect and its extent and magnitude in the far field will depend upon the characteristics of the sediments being released (controlling the duration of time spent in suspension), the water depth (affecting the volume of water for dispersion and dilution) and the current speed and direction, both at the time of release and the residual current over longer periods of time (affecting rates and direction of advection). A change in levels of SSC locally does not necessarily imply an effect, if there are no receptors present that are sensitive to the change. Other consequential (indirect) effects are also considered, where relevant, in other ES chapters (Chapter 4.1: Benthic Ecology, Chapter 4.2: Fish and Shellfish Ecology and Chapter 5.4: Archaeology).

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3.1.2.51 On the basis of the evidence base (Royal Haskoning & BOMEL, 2008), cable installation by burial into the seabed along the modified offshore export cable route corridor will have a relatively large magnitude effect on SSC (elevated to order 100s to 10,000s mg/l). However, the effect will be short-term (order of seconds to minutes, depending on the sediment grain size and degree of aggregation) and will be largely localised to the cable installation location (main effect within 10s of metres).

3.1.2.52 Previously undertaken monitoring of SSC levels during similar cable installation works (e.g. ABPmer, HR Wallingford & CEFAS, 2010) have consistently validated this general assumption.

3.1.2.53 In order to quantify the likely estimated levels of effect in the present study, the following assessment presents a worst case scenario for energetic sediment release, expressed per metre of trench length.

- The maximum trench dimensions for all proposed burial methods are 3 m wide at the surface x 3 m deep with a 'V' shaped profile = 4.5 m^3/m sediment disturbance;
- It is assumed that in the worst case, all of the material disturbed will be ejected from the trench = 4.5 m^3/m sediment release;

- The porosity of the material is conservatively estimated as 20 % void = 3.6 m^3/m sediment material release;
- The material is likely a quartz mineral with density 2650 kg/m^3 = 9,540 kg dry mass sediment release per metre of trench dug;
- The resulting levels of SSC depend upon the volume of water into which this sediment volume is mixed (which is in turn dependent upon the height of sediment ejection, the settling rate of the sediment and the ambient current speed); and
- The resulting thickness of sediment deposition depends upon the area of seabed over which this sediment volume is deposited (also dependent upon the height of sediment ejection, the settling rate of the sediment and the ambient current speed).

3.1.2.54 The elevation to which the sediment might be ejected is not known with certainty and may vary between burial methodologies, sediment types and the nature of the hydrodynamic regime at the time of the release. A lower height of ejection will result in a higher level of SSC and thickness of deposition but with a smaller footprint of effect, and vice versa. This uncertainty is addressed here by providing results for a range of nominal ejection heights.

3.1.2.55 Surficial seabed sediments are typically sands or gravelly sands within the three consented wind farms, however, these are generally only present as a relatively thin surface layer (~0.5 m thick). The dominant grain sizes present in these sandy surface sediments are medium sands (250-500 µm diameter). In the sandy layers, the fine material content is known to be small (<5 %) and any gravel content will deposit directly to the seabed locally. The settling velocity of such medium sands is approximately 0.05 m/s (using equations from Soulsby (1997).

3.1.2.56 Below the sandy veneer are till deposits, characterised as stiff clays with coarse inclusions. It is most likely that this material will arise as large chunks, depositing directly to the seabed locally without remaining in suspension. For the purposes of the present study, a worst case assumption is that all sediments arise as a fully fluidised mixture. The settling velocity of such fine material is approximately 0.0001 m/s (using equations from Soulsby (1997).

3.1.2.57 The typical peak tidal current speed in the three consented wind farms and so at the start of the OfTI export cable corridor is 0.5 m/s on mean spring tides and 0.25 m/s on mean neap tides. Values are typically lower elsewhere along the corridor. The value 0.25 m/s is used here as a condition representative of most normal states of flow during individual tides and over the spring-neap cycle.

3.1.2.58 These values are applied in Table 3.1-4 to Table 3.1-6 below to quantify the total effect per metre of trench length dug. The table assumes that the total mass of sediment (9,540 kg) is resuspended evenly up to a (variable) ejection height. The time required for sediment to settle (at 0.05, 0.005 or 0.0001 m/s for gravel, sand or fines, respectively) through the nominal height of ejection is calculated to yield the duration of the effect. The length scale of the effect is the furthest distance travelled by the plume (in a downstream direction), found as the product of the ambient current speed (0.25 m/s) and the duration of the effect. The estimate of mean SSC is found by dividing the total mass of sediment by the volume of the triangular wedge of water through which the sediment will settle ([ejection height x downstream distance] ÷ 2). The average thickness of any resulting seabed deposit is found by dividing the total volume of sediment (4.5 m^3) by the footprint (length scale of the effect x 1 m).

3.1.2.59 Table 3.1-4 to Table 3.1-6 below provide an indicative range of results for trenching along the cable route, which may include a variety of sediment types, including nominally gravelly, sandy and muddy sections.

Table 3.1-4. Extent and magnitude of effect of export cable trenching in gravels (settling velocity 0.5 m/s)

Ejection Height (m)	Duration of Effect (s)	Length Scale of Effect (m)	Indicative Mean SSC (mg/l)	Average Thickness of Deposit (m)
1	2	<1	38,160,000	9.000
5	10	3	1,526,400	1.800
10	20	5	381,600	0.900
25	50	13	61,056	0.360

Table 3.1-5. Extent and magnitude of effect of export cable trenching in medium sands (settling velocity 0.05 m/s)

Ejection Height (m)	Duration of Effect (s)	Length Scale of Effect (m)	Indicative Mean SSC (mg/l)	Average Thickness of Deposit (m)
1	20	5	3,816,000	0.900
5	100	25	152,640	0.180
10	200	50	38,160	0.090
25	500	125	6,106	0.036

Table 3.1-6. Extent and magnitude of effect of export cable trenching in fine sediments (settling velocity 0.0001 m/s)

Ejection Height (m)	Duration of Effect (s)	Length Scale of Effect (m)	Indicative Mean SSC (mg/l)	Average Thickness of Deposit (m)
1	10000	2500	7,632	0.002
5	50000	12500	305	<0.001
10	100000	25000	76	<0.001
25	250000	62500	12	<0.001

3.1.2.60 The assessment shows that cable burial will lead to:

- Levels of SSC potentially elevated above the natural range of variability, but:
  - Only over a small distance or area;
  - Only close to the seabed; and
  - Only as a temporary effect and typically lasting only a short time.
- The resulting thickness of deposition may exceed the range of natural variability in seabed level, but:
  - Only over a small distance or area; and
  - Fine grained material will likely be dispersed and deposited over such a wide area that the thickness will not be measurable in practice (<1 mm).

3.1.2.61 A critical thickness of sediment deposition with relevance to benthic ecology is 0.05 m. Given the finite dimensions of the trench, the maximum possible distance from the trench over which displaced sediment of any type might deposit to a thickness of 0.05 m is 90 m, i.e. affecting an area of 90 m^2 seabed, per metre of trench installed. Dispersion over a larger area would lead to a smaller thickness of deposition. In practice the deposition is likely to be confined to a smaller area, with a correspondingly greater average thickness. Such a thickness of sediment is in the same order as that which might be disturbed and redeposited during a large storm event.

3.1.2.62 With regards to fine sediments, it is more likely that if resuspension occurs, sediments will disperse throughout much of the water column and, as shown in Table 3.1-6, resulting levels of SSC and the thickness of any subsequent deposits would be very small and within the range of natural variability.

3.1.2.63 Consistent with the findings of Royal Haskoning and BOMEL (2008), locally redeposited sands and gravels will be of the same type as that naturally present and so will not cause any change to the seabed sedimentary character. Where fine material is deposited onto another sediment type in a sufficient thickness, it may temporarily affect sediment character until it is dispersed. Once deposited, all sediment will join the natural sedimentary environment and essentially ceases to present any further effect.

3.1.2.64 The effects of export cable burial on SSC is of a magnitude potentially in excess of the natural range of variability. However, the effect will be localised and temporary.

3.1.2.65 A small to medium magnitude of change locally and temporarily exceeding the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in a temporary negative effect and an effect of **minor significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.66 It is noted here that within MORL (2012), an assessment was made relating to potential effects associated with the installation of two cable trenches whereas the modified OfTI includes for up to four cable trenches. However as previously stated, these cables will not be installed simultaneously so each event will be discrete from one another. Accordingly, the nature, magnitude, sensitivity and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

Increase in Suspended Sediment Concentrations and Changes in Sediment Type/ Thickness at the Seabed as a Result of OSP Foundation Installation Activities

3.1.2.67 An increase in SSC may arise during any drilling activities used for pin piling the foundations. The magnitude of the effect locally will depend upon the sediment release rate. The nature of the effect and its extent and magnitude in the far field will depend upon the characteristics of the sediments being released (controlling the duration of time spent in suspension), the water depth (affecting the volume of water for dispersion and dilution) and the current speed and direction, both at the time of release and the residual current over longer periods of time (affecting rates and direction of advection). A change in levels of SSC locally does not necessarily imply an effect, if there are no receptors present that are sensitive to the change. Other consequential (indirect) effects are also considered, where relevant, in other ES chapters (Chapter 4.1: Benthic Ecology, Chapter 4.2: Fish and Shellfish Ecology and Chapter 5.4 Archaeology).

<u>Sensitive Receptor: The Smith Bank</u>

3.1.2.68 The release of sediment into the upper water column during drilling works will initially lead to a local increase in suspended sediment concentration. The resulting sediment plume will be advected with ambient tidal currents and will be subject to general processes of dispersion, deposition and re-suspension over time.

3.1.2.69 To quantitatively estimate the likely magnitude and extent of the increase in SSC, currents from the calibrated and validated tidal model were used in conjunction with a plume dispersion model (MORL, 2012). It was found that in the worst case, drilling pin piles for jack-up foundations would yield the following:

- The maximum localised increase in SSC is predicted to be 30-40 mg/l, depending on the state of the tide and the local water depth at the time and location of the release. These maximum levels of effect are contained within 50-100 m of the dredger and only occurring during sediment release;

- SSC in the advected main plume (centred along the downstream tidal axis) is reduced to 20 mg/l or less by 500-1,000 m downstream and to 10 mg/l or less by 2,000-3,000 m downstream;
- The effects described above are only present during and up to 1 hour after the cessation of drilling, after which time, SSC is reduced to < 4 mg/l due to dispersion and deposition to the seabed;
- In principle, the maximum length of the advected main plume is initially limited to the tidal excursion (7.1 km on spring tides, 3.6 km on neap tides) but will normally be less than this as each drilling (release) event lasts less than one half tidal cycle;
- Fine material deposited to the seabed can be resuspended by stronger currents during spring tides (> 0.3-0.4 m/s) or by storm events, leading to a dispersed low level increase in SSC of 1 to 2 mg/l;
- Sands deposited to the seabed will merge with the naturally present sedimentary environment and pose no further impact if subsequently reworked;
- Re-suspended material is mostly re-deposited to the seabed (SSC <1 mg/l) when current speeds fall below the locally critical value (i.e. during neap tides and around slack water periods during spring tides); and
- The dispersed small magnitude effects on SSC are advected in a net south or south westerly direction outside of the site, i.e. the direction of residual transport by tidal currents.

3.1.2.70 The resulting thickness of deposition may exceed the range of natural variability in seabed level, but:

- Only over a small distance or area; and
- Fine grained material will likely be dispersed and deposited over such a wide area that the thickness will not be measurable in practice (<1 mm).

3.1.2.71 Effects are generally of a magnitude consistent with the natural range of variability (<5 mg/l during calm periods to 100s to 1,000s mg/l near to the seabed during storm events). Local effects around the dredger may however be potentially in excess of the natural range of variability in the upper water column but will be localised and temporary.

3.1.2.72 Drilling in the marine environment is a well-established practice and so will be subject to a number of embedded mitigation measures in the design of the machinery and methodologies normally employed. This will likely limit levels of SSC resulting from the normal operation of such machines to levels that are generally acceptable according to a broad range of standards and in a variety of different environments.

3.1.2.73 A small magnitude of change that may locally and temporarily exceed the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in a negative effect of **minor significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.74 The nature, magnitude and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The duration and extent of the predicted potential effect are however reduced, due to the smaller number of OSPs being installed (2 instead of 8).

Disturbance of Coastal Morphology at the Landfall Site

3.1.2.75 The modified OfTI will be buried through the nearshore, intertidal, beach and hinterland areas of the modified export cable landfall location. The disturbance caused by this operation may potentially lead to resuspension of sediments and a disruption to coastal processes. A full cable landfall impact assessment has been undertaken and results presented in Technical Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes. Key details are summarised below.

<u>Sensitive Receptor: Export Cable Landfall, Seabed Along the Modified OfTI Corridor, Cullen to Stake Ness Coast SSSI & Whitehills to Melrose Coast SSSI</u>

3.1.2.76 Open trenching techniques involve mechanically excavating a trench through the beach and hinterland to the jointing bay. The offshore export cable is placed in the trench, which is then backfilled. Open cut trenching can be a fast, economical means of installing cables but the technique poses some engineering challenges in a tidal environment to keep the trench open during tidal inundation.

3.1.2.77 Excavating a trench across the nearshore and intertidal zone has the potential to affect local morphology and sedimentary processes, including the relative bed level, seabed mobility and local longshore sediment transport. Trench excavation would be completed (potentially requiring ongoing excavations to maintain the trench opening and depth during subsequent tidal cycles) before the cable is installed and the trench backfilled. It is possible that the excavation will include both the temporary removal of sand and cutting of rock in places to locate the cable below the minimum expected bed level. A temporary jointing pit may be used during installation, which may be located in or above the intertidal zone. Given that the main operations will likely be undertaken during relatively calm conditions (when longshore transport rates are minimal) and only lasting a short period of time (expected to be no more than a few days), the only expected effect on coastal processes is likely to be a temporary and localised increase in SSC and the temporary presence of either a trenched depression or furrow in the beach. With or without backfilling, a trench in sand will be quickly incorporated back into the natural environment within at most a few tidal inundations. No more extensive or longer term effect is expected.

3.1.2.78 To justify the assumption of no potential for long term interaction between open trenched export cables and the coastal zone, the export cable burial design should meet the following conditions during the expected lifetime of the installation:

- Where practicable, the export cable will be suitably deeply buried from onshore to the depth of closure (the area of seabed normally exchanging sediment with the beach on seasonal and inter-annual time scales) to prevent export cable exposure. This depth will be determined as part of the detailed engineering plan and will also consider any requirements for protection; and
- Any fixed onshore infrastructure (with the exception of the temporary jointing pit) will be located onshore of the high-water mark and any important coastal features, accounting for any predicted coastal retreat.

3.1.2.79 If practicable, HDD may be used instead of trenching to create an underground conduit for the cable between the offshore and onshore parts of the route at the landfall. This method has historically been shown to cause minimal direct disturbance to the existing coastline and will also not leave any infrastructure exposed in the active parts of the beach (onshore or offshore) and so will not affect littoral processes.

3.1.2.80 To justify the assumption of no potential for interaction between the cables and the coastal zone, the HDD route design would meet the following conditions during the expected lifetime of the installation:

- The seaward exit point of the HDD will be located as far offshore as practicable towards the depth of closure;
- The cable will also be buried to a suitable depth between the seaward exit of the HDD and the depth of closure; and
- The landward exit point of the HDD will be located onshore of the high-water mark and any important coastal features, accounting for any predicted coastal retreat.

3.1.2.81 The majority of drill arisings will be captured at the onshore end of the HDD route and so will not cause any effects with regards to water quality during installation.

3.1.2.82 A quantitative assessment (based on the sediment types present and the typical intra-annual wave regime at the landfall location, derived from the wave models) indicates that the beach closure depth in the vicinity of the proposed landfall location is in the order of 11 m. It is conservatively assumed that this depth is relative to the Lowest Astronomical Tidal water level (LAT). There can be no potential for the offshore export cable to interact with the wave, tidal or sedimentary regimes directly associated with maintaining the beach, provided that an adequate depth of burial (either through trenching or HDD, or a combination of both) is achieved between the beach and offshore of the present day 11 m depth contour. Climate change will lead to mean sea level rise and so will not affect the identified locations on the basis of present day bathymetry.

3.1.2.83 The effects of offshore export cable landfall operations are generally of a magnitude consistent with the natural range of variation in beach morphology. The main effects during installation will be localised (order of metres). Effects of open trenching will also be temporary (order of hours to days) in most locations except where dune crests or vegetation are disturbed (order of days to months or years). During the operational phase, provided a sufficient burial depth is achieved and the landward jointing station is located sufficiently far back to account for rollback of the dunes in the lifetime of the installation, the cable landfall will have no further potential to affect the morphology of the coastline.

3.1.2.84 This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.85 The nature, magnitude, extent, duration and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

Operation

Changes to the Tidal and Wave Regimes (Transmission Cable)

3.1.2.86 Cables will be buried beneath the seabed or under cable protection measures. Introducing materials to the baseline environment that are proud of the seabed will present some small blockage to water movements locally.

<u>Sensitive Receptor: The Smith Bank, Designated Sites and Recreational Surfing Venues</u>

3.1.2.87 It is anticipated that during operation, the offshore export cables will be buried either in a trench or under other protective materials. Buried cables present no obstacle to flows and so will not interact with the tidal and wave regimes. The dimensions of cable protection materials (maximum approximately 1 m high and in the order of 2-3 m wide with a sloped profile) are small both in an absolute sense and relative to the water depth. As such, cable protection measures have very little potential to interact with, or therefore to affect the ambient wave and tidal regimes.

3.1.2.88 Sections of offshore export cable and/or cable protection measures that are (or become) exposed on the seabed have the potential to interact locally with tidal and wave flows but are of too small a physical scale to modify the regimes. The extent of any effect is similar to that described in relation to local scour.

3.1.2.89 A negligible magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.90 The nature, magnitude, extent, duration and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

Changes to the Tidal and Wave Regimes (OSPs)

3.1.2.91 Changes to the tidal and wave regimes (water levels and currents and the joint statistics of wave height, period and direction) may arise from interaction of tidal currents and individual waves with obstacles in the water column (in this case the OSP foundations). The effect of individual foundations is principally controlled by the foundation shape and dimensions. The effect of multiple foundations is additionally controlled by the total number of foundations, their spacing and layout relative to tidal currents or wave direction. A change in tides or waves (instantaneous magnitude and direction within the range of natural variability) alone is not considered to constitute an effect as there are no physical process receptors that are directly sensitive to such changes. Consequential (indirect) effects on the sedimentary environment are considered in the following assessment section. Other consequential (indirect) effects are also considered, where relevant in other ES chapters (Chapter 4.1: Benthic Ecology, Chapter 4.2: Fish and Shellfish Ecology and Chapter 5.4 Archaeology).

<u>Sensitive Receptor: The Smith Bank, Designated Sites and Recreational Surfing Venues</u>

3.1.2.92 An assessment of the effect on tidal and wave regimes of up to 339 turbine foundations and eight OSPs in the three consented wind farms was provided in the MORL ES (MORL, 2012, Chapter 13.1). The effect of the three sites together was shown to be not significant. It is noted that the consented wind farms will actually contain fewer (up to 186) turbines.

3.1.2.93 A single jacket OSP foundation presents blockage to waves equivalent to less than one of the individual GBS foundations previously tested. The additional effect of two OSPs also located within or immediately adjacent to the array is therefore much smaller than the array scale effect of all turbine foundations, as previously assessed in the MORL ES (MORL, 2012; Chapter 13.1). A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.94 The nature and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude, duration and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8).

Changes to the Sediment Transport Regime Due to the Presence of the OSP Foundations

3.1.2.95 The sediment transport regime (rates, directions and the nature of sediment transport) is controlled by the interaction of surficial seabed sediments with the tidal and wave regimes locally.

Sensitive Receptor: The Smith Bank

3.1.2.96 It is the combined wave and tidal regimes that ultimately control sediment transport and therefore the seabed form. It was shown in the MORL ES (MORL, 2012) that the OSPs (realistically only considered in conjunction with the associated wind farm developments) cause no significant change to the speed, direction or asymmetry of tidal currents. It was also shown that an array of 339 turbine jacket foundations will have little or no measureable effect (<2%) on wave height, wave period or direction.

3.1.2.97 Given no significant effect on the parameters controlling patterns of sediment transport, in particular the direction and asymmetry of tidal currents, there will be no corresponding difference in the potential rates and directions of sediment transport (provided that the supply of sediment is available for transport). There will, therefore, be no change to the form or function of the Smith Bank.

3.1.2.98 A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.99 The nature and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude, duration and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8).

Sensitive Receptor: Designated Coastal Habitats

3.1.2.100 As described above, there will be no measureable effect on sediment transport rates through the three consented wind farms as a result of their presence (including the OSP foundations).

3.1.2.101 There will therefore be no effect on the form or function of designated coastal habitats located outside of the wind farm sites.

3.1.2.102 A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low to medium sensitivity. This effect is therefore of **minor significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.103 The nature and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude, duration and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8).

Scour Effects Due to the Presence of the OSP Foundations

3.1.2.104 Scour can occur as the result of a localised increase in erosion potential, caused by the interaction between obstacles and water movements near to the seabed. As such, extensive scour is not naturally present in the marine environment and its introduction may constitute a further area of modification to the nature and level of the seabed. In addition to the slopes that may develop, the surface of the scour pit may develop a sediment texture different to that of the ambient seabed due to the difference in sediment transport potential. A full scour assessment for the OSPs has been undertaken and results presented in Appendix 3.1 A: Hydrodynamics, Sedimentary and Coastal Processes. Key details are summarised below.

Sensitive Receptor: The Smith Bank

3.1.2.105 There is a potential for scour to develop where and when scour protection is not applied, possibly in the interim period between installation of the foundation and placement of the protection.

3.1.2.106 The jack-up foundations for OSPs may cause a maximum local scour depth of approximately 3.9 m. In reality, this depth is unlikely to be attained, at least in all locations around a given foundation, due to the use of scour protection and the presence of erosion resistant strata beneath the relatively thin layer of marine sediments that are present. The presence of gravel in the upper sandy layers will likely also lead to bed armouring in the scour pit that will restrict the overall depth or rate of scour development. Also, the consolidated till surface at approximately 0.5-2 m below the seabed is described as layered sandy silty clays of variable density and hardness (MORL ES, 2012, Technical Appendix 3.4 A: Metocean and Coastal Processes Baseline) and therefore is likely to be generally cohesive, consolidated and largely more resistant to erosion than non-cohesive (sandy) sediments.

3.1.2.107 The extent of scour from the edge of a foundation is calculated assuming the profile of the scour pit is an inverted cone with slopes at the angle of repose for sand (32°). It is noted that the separation between individual large items of infrastructure is in the order of hundreds of metres and the greatest extent of scour from the centroid of a foundation location is only 51 m. Therefore, scour effects are not predicted to interact or coalesce, e.g. between OSP and WTG foundations. The net additional footprint of scour from OSPs will be a proportionally small increase in the predicted area for all wind farm foundations (i.e. <1% of 0.54% of the total site area affected).

3.1.2.108 The time theoretically required for the majority of equilibrium scour pit development around a foundation is in the order of hours to days under flow conditions sufficient to induce scour. This assumes that the seabed is potentially mobile and comprises uniform non-cohesive sediment. Approximately symmetrical scour will only develop following sufficient exposure to both flood and ebb tidal directions. Waves of a sufficient size to interact with the seabed do not typically directly cause rapid initial scour but can increase the rate of initial scour development.

3.1.2.109 The effects of the foundations in causing scour are of a small to medium magnitude relative to the range of naturally occurring variability in seabed level but do not cause the normal range of water depths to be exceeded. The effects of scour around OSPs, especially alone but also in conjunction with the wind farm infrastructure are limited to only a small proportion of the area of each of the three consented wind farms and an even smaller proportion of the area of the Smith Bank.

3.1.2.110 A small to medium magnitude of change that does not exceed the range of natural variability is therefore assessed to arise in an area of low sensitivity. This effect is therefore of **minor significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.111 The nature, duration and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller dimensions of individual OSPs relevant to scour (jack-ups instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8).

Scour Effects Due to the Exposure of Offshore Export Cables

3.1.2.112 Structures introduced into the marine environment and located near to the seabed will interact with the naturally present hydrodynamic and sedimentary regimes, resulting in the potential for scour to occur. The removal of sediment from underneath a section of export cable exposed on the seabed can lead to free-spanning and further sediment erosion; exposed export cables are also at greater risk of physical damage. Exposure and scour is primarily an engineering risk, often mitigated using export cable burial and scour protection.

3.1.2.113 The export cables will be buried where seabed conditions allow. Where seabed conditions do not allow for adequate burial, cables may be partially buried or surface laid and protected with other means.

3.1.2.114 The source of the potential effects considered in this section are the interaction between the naturally present metocean regime (waves and currents) and sections of export cable or cable protection measures exposed on the seabed surface during the operational phase of the development.

3.1.2.115 Exposure of the export cable has the potential to cause localised scouring of sediment, leaving a depression and/or a relative change in sediment character that will persist until the export cable is either buried or otherwise removed. The extent and depth of scour may vary over time and may be limited under certain physical conditions; however, a conservative approach has been applied to calculating the maximum expected dimensions independent of other factors. Depending upon the nature of the seabed surface sediments, the presence of a depression does not necessarily imply a difference in sedimentary environment in the area of effect.

3.1.2.116 Cables can be buried to reduce the risk of snagging or other direct contact damage and, therefore, normally present no scour risk. Cable burial may not be possible at the j-tube exits of the foundations, in areas with unsuitable seabed soil conditions, or at crossing points with other cable or pipeline infrastructure. In these situations, scour protection measures are typically used to mitigate the risk of scour, and other damage and will largely prevent scour developing. However, the area occupied by the scour protection might also be considered as a modification to the sedimentary environment and may result in localised secondary scour or (depending on the dimensions and orientation) pose an obstacle to local sediment transport pathways.

<u>Sensitive Receptor: The Smith Bank & seabed along the modified OfTI corridor</u>

3.1.2.117 The diameter of the offshore export cable is likely to be in the order of 0.25 m and up to four cables might be laid in individual trenches separated by tens or hundreds of metres, depending on the local water depth. From Whitehouse (1998), a conservative estimate for all cases (current, wave or combined scour) is that the maximum depth of scour beneath a section of exposed cable will be between one and three times the cable diameter (i.e. order of 0.75 m) and the maximum horizontal extent of any scour effect will be up to fifty times the cable diameter (i.e. order of 12.5 m). As such, any depression created will not necessarily be steeply sided. In predominantly sandy areas, the surface of the scour pit will be of similar character to the ambient bed. In more gravelly areas, a gravel lag veneer may initially form as finer sands are preferentially winnowed. This may then become buried by predominantly sandy material following recovery of the seabed if self-burial of the cable occurs.

3.1.2.118 The effects of scour potentially resulting from the exposure of offshore export cables onto the seabed are considered to be of a small magnitude relative to the range of naturally occurring variability. Effects on morphology or sediment surface texture will be localised to the cable route.

3.1.2.119 This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.120 The nature, magnitude, sensitivity and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

Scour Effects Due to Cable Protection Measures

3.1.2.121 Scour can occur as the result of a localised increase in erosion potential, caused by the interaction between obstacles and water movements near to the seabed. As such, extensive scour is not naturally present in the marine environment and its introduction may constitute a further area of modification to the nature and level of the seabed. In addition to the slopes that may develop, the surface of the scour pit may develop a sediment texture different to that of the ambient seabed due to the difference in sediment transport potential.

<u>Sensitive Receptor: The Smith Bank & seabed along the modified OfTI corridor</u>

3.1.2.122 Protection measures that might be deployed onto surface laid or otherwise exposed sections of the offshore export cables may take various forms, but will most likely comprise:

- Rock placement; or
- Concrete mattressing.

3.1.2.123 Protection measures are used to mitigate the engineering risk posed by scour and exposure of the offshore export cable to external damage. The measures will prevent scour from developing around the cable; however, the area occupied by the scour protection might also be similarly considered as a modification to the sedimentary environment and may cause a more limited depth and area of secondary scour to develop.

3.1.2.124 There is insufficient information available to accurately quantify the effect of all possible types of protection measure, which may vary greatly in design and scale. The maximum thickness of the protection will be in the order of 1 m. The total width of the protection material will be in the order of 2-3 m either side of the offshore export cable itself, likely with a sloping or tapering profile.

3.1.2.125 The slope angle presented by sections of protected cable would be in the order of 5-9° which is within the natural range of bed slope angles associated with bed forms and so will not affect patterns of sediment transport following the initial period of accumulation.

3.1.2.126 Alternatively, conditions may not be favourable for sediment accumulation. Where this is due to very low transport rates (e.g. in the central part of the outer Moray Firth), the presence or absence of an obstacle will therefore not cause any further effect. Where this is due to a tendency for the protection material to create turbulence and secondary scour, the action of the (upstream) scour will be to actively resuspend and transport sediment over the obstacle, again therefore not causing any further effect.

3.1.2.127 The effects of cable protection measures are considered to be of a small magnitude relative to the range of naturally occurring variability and will not have a measurable effect on sediment transport beyond a short to medium term period of initial adjustment. Effects on morphology or sediment surface texture will be localised to the cable route.

3.1.2.128 This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

3.1.2.129 The nature, magnitude, extent, duration and significance of the predicted potential effect from the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

Decommissioning

3.1.2.130 Where and when the modified OfTI is no longer present, there is no potential for any effect on the baseline wave and tidal regimes. The worst case scenario of the modified OfTI being present is considered in the preceding sections. The effect of less than the proposed total amount of OfTI present at an intermediate stage in the decommissioning process will be (generally proportionally) less than that reported (as not significant) for the operational phase of the development (i.e. of a small magnitude and within the range of natural variability).

3.1.2.131 In relation to sedimentary and coastal processes, it is considered that the methods likely to be employed during decommissioning will be of a similar general nature but overall less energetic and disturbing a smaller volume of sediment than previously assessed in relation to construction. Therefore, the types of effect from decommissioning and their significance can only be considered to be similar to or less than that already provided above (either negligible significance or of minor significance).

3.1.2.132 Whether removed or left in-situ, decommissioned cables have no greater potential effect upon sediment transport and coastal morphology than as described above for the construction and operational phases, respectively.

3.1.2.133 The same conclusions were reached in the MORL ES (MORL, 2012).

Proposed Monitoring and Mitigation

Construction

3.1.2.134 No mitigation measures are proposed.

Operation

3.1.2.135 Where burial depth cannot be achieved, cable armouring will be implemented (e.g. rock placement or concrete mattressing). The suitability of installing rock or concrete mattresses for cable protection, especially around the structure bases, will be assessed based on the seabed current data across the proposed development area and the assessed risk of impact damage.

3.1.2.136 During operation, the export cable will be monitored to ensure that cables remain buried and any scour effects remain within the range of that predicted in the ES.

Decommissioning

3.1.2.137 No mitigation measures are proposed.

Habitat Regulations Appraisal

3.1.2.138 Likely effects from the construction, operation and decommissioning of the modified OfTI on the wave and tidal regime and sedimentary and coastal processes are of negligible significance and therefore do not give rise to Habitats Regulations Appraisal concerns. The effects on the physical marine environment considered in this section are also considered with respect to the requirements for Habitats

Regulation Assessment in other ES chapters (Chapter 4.1: Benthic Ecology, Chapter 4.2: Fish and Shellfish Ecology and Chapter 4.4: Marine Ornithology).

3.1.3 *Cumulative Impact Assessment*

Summary

3.1.3.1 This section presents the results of an assessment into the potential cumulative effects upon hydrodynamic, sedimentary and coastal processes arising from the whole Project (the modified OfTI plus Telford, Stevenson and MacColl) in conjunction with other existing or reasonably foreseeable marine coastal developments and activities (Table 3.1-7). MORL's approach to the assessment of cumulative effects is described in Chapter 1.3: Environmental Impact Assessment.

3.1.3.2 The MORL ES (MORL, 2012) provided a detailed assessment of potential effects from all relevant developments, both individually and cumulatively. The preceding impact assessment demonstrates that the nature, magnitude, extent, duration and significance of the potential effects from the modified OfTI are the same or less than previously assessed in the MORL ES (MORL, 2012). Comparable aspects of the other, now consented, developments considered for cumulative effects have either stayed the same, or have been refined (reduced) since the previous assessments were made. Therefore, the nature, magnitude, extent, duration and significance of cumulative effects also remain the same or are reduced.

Table 3.1-7 Cumulative Impact Summary

Effect/Receptor	Residual Significance Level for Modified TI	Whole Project Assessment: Modified TI + Stevenson, Telford and MacColl	Mitigation Method
Construction			
Changes to the Tidal and Wave Regimes	Negligible	n/a (Impacts subordinate to those assessed for operational phase)	None proposed
Total Cumulative Impact Assessment ***(Whole project + developments as listed in section 3.1.3.4)***	n/a (Impacts subordinate to those assessed for operational phase)		
Increase in suspended sediment concentrations and changes in sediment type/thickness at the seabed (receptor: The Smith Bank)	Minor significance	Minor significance	None proposed

Total Cumulative Impact Assessment ***(Whole project + developments as listed in section 3.1.3.4)***	Minor significance		
Disturbance of coastal morphology at the landfall site (Inverboyndie landfall)	Negligible significance	Negligible significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Negligible significance		
Operation			
Changes to the tidal regime (receptor: The Smith Bank)	Negligible significance	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Changes to the tidal regime (receptor: Designated Sites)	Minor significance	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Changes to the tidal regime (receptor: Stratification Fronts)	Not assessed	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		

Changes to the wave regime (receptor: The Smith Bank)	Negligible significance	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Changes to the wave regime (receptor: Designated Coastal Habitats)	Minor significance	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Changes to the wave regime (receptor: Recreational Surfing Venues)	Negligible significance	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Changes in sediment transport (receptor: The Smith Bank)	Negligible significance	Minor significance	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Changes in sediment transport (receptor: Designated Coastal Habitats)	Negligible significance	Minor significance	None proposed

Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Scour Effects	Negligible significance	Minor significance	Scour protection
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	Minor significance		
Decommissioning			
Partial impacts only for all effects and receptrs	As 'Construction'	As 'Construction'	None proposed
Total Cumulative Impact Assessment (Whole project + developments as listed in section 3.1.3.4)	As 'construction' – Negligible / minor significance depending on effect and receptor		

Assessment of Cumulative Effects

3.1.3.3 A whole Project assessment has been done for the likely significant cumulative effects of the modified OfTI in conjunction with the three consented wind farms (Telford, Stevenson and MacColl).

3.1.3.4 The following wind farm developments were considered in detail for the total cumulative impact assessment for the whole Project:

- MORL Western Development Area (WDA); and
- BOWL wind farm and associated OfTI.

3.1.3.5 Additional developments and projects within the Moray Firth were also considered when scoping the total cumulative impact assessment:

- MORL Offshore Met Mast;
- Beatrice Wind Farm Demonstrator Project;
- Burghead wave energy project;
- Mains Carbon capture and storage site;
- Nigg, Ardeseir and Invergordon port works;
- SHE-T Offshore HVDC reinforcement; and
- Buckie and Macduff waste disposal sites.

3.1.3.6 However, these additional developments and projects are considered to have no potential for cumulative interaction for one or more of the following reasons.

- The development is located more than one tidal excursion from the whole Project;
- The development has no direct fetch for wave effects to interact with that from the whole Project (i.e. there is no pathway connecting the wind farm sites and the other source of effect); and/or
- The dimensions of the development (or the effects they give rise to) are so small that it will not conceptually have any measurable effect on the tidal, wave or sedimentary regimes.

Methodology

3.1.3.7 The assessment methodology has followed that outlined in the Moray Firth Offshore Wind Developers Group Discussion Document (MORL, 2012, Technical Appendix 1.3 D: MFOWDG Cumulative Assessment Document).

3.1.3.8 To assess cumulative effects upon the wave climate and tidal regime, the effect of different layouts and types of turbine foundations was simulated using calibrated and validated numerical models. The relative difference between the two sets of results was found and used to describe and assess the relative effects. By testing the realistic worst cases and testing the effects as the difference between scheme and baseline results, any uncertainties in either the design of the development or the absolute accuracy of the numerical modelling are minimised; this approach complies with the best practice guidance in this regard (COWRIE, 2009).

Worst Case Scenario for Projects Where Detailed Assessment is Possible

3.1.3.9 The worst case parameters for the modified OfTI are as provided in this ES Project Description, Chapter 2.2.

3.1.3.10 A summary of the worst case parameters previously assessed in the MORL ES (MORL, 2012) for the offshore generating station is provided below in Table 3.1-8. The worst case layout of the MORL offshore generating station in conjunction with the BOWL wind Farm was 139 x 3.6 MW turbines in Telford and 100 x 5 MW turbines in each of Stevenson and MacColl. This distribution placed the greatest density of turbines closest to the nearest coastline and therefore resulted in the greatest predicted far-field effects.

3.1.3.11 The number of turbines actually consented is much smaller (up to 186 to be built instead of 339 assessed as the realistic worst case). As the foundation type and dimensions are not changed, the number of occurrences and so total duration of individual impacts, and array scale effects, will therefore be proportionally reduced to approximately 55% of the previously assessed values.

Table 3.1-8 Summary of MORL Three Consented Wind Farms Worst Case Parameters (as previously assessed but with commentary on consented parameters)

Previously Assessed Realistic Worst Case Parameters	Scenario Previously Assessed
Changes to the Tidal Regime	
Installation of 339 turbines (186 turbines consented)	65 m diameter Gravity Base Structures (GBS)
Changes to the Wave Regime	
Installation of 339 turbines (186 turbines consented)	65 m diameter Gravity Base Structures (GBS)

Previously Assessed Realistic Worst Case Parameters	**Scenario Previously Assessed**
Increase in Suspended Sediment Concentrations	
Installation of 339 turbines (186 turbines consented)	Dredging for GBS bed preparation. Drill arisings from jacket pin pile installation.
Inter-array cable burial	Energetic trenching tool, 'V' shaped trench 3 m wide and up to 3 m deep, 100% resuspension.
Sediment accumulation and change of sediment type at the seabed	
Installation of 339 turbines (186 turbines consented)	Dredging for GBS bed preparation. Drill arisings from jacket pin pile installation.
Changes to the Sediment Transport Regime	
Installation of 339 turbines (186 turbines consented)	65 m diameter Gravity Base Structures (GBS)
Scour Effects	
Installation of 339 turbines (186 turbines consented)	65 m diameter GBS

3.1.3.12 A summary of the worst case design parameters for the BOWL wind farm and associated OfTI in terms of the wave climate and tidal regime used in the original assessment provided below in Table 3.1-9. These parameters were consistent with the descriptions and assessments contained in the Beatrice Offshore Wind Farm Environmental Statement (BOWL, 2012). The number of turbines actually consented for BOWL is much smaller with 125 (or up to 140 if certain conditions can be met) to be built instead of the 227 assessed as the realistic worst case in the original assessment. As the foundation type and dimensions are not changed, the number of occurrences and so total duration of individual impacts and array scale effects will therefore be proportionally reduced to between approximately 55-62% of the previously assessed values.

Table 3.1-9 Summary of BOWL Worst Case Parameters (as previously assessed but with commentary on consented parameters)

Previously Assessed Realistic Worst Case Parameters	**Scenario Previously Assessed**
Changes to the Tidal Regime	
Installation of 277 turbines (125 turbines consented but with the potential for up to 140 turbines as per conditions)	60 m diameter Gravity Base Structures (GBS)
Changes to the Wave Regime	
Installation of 277 turbines (125 turbines consented but with the potential for up to 140 turbines as per conditions)	60 m diameter GBS
Increase in Suspended Sediment Concentrations	

Previously Assessed Realistic Worst Case Parameters	**Scenario Previously Assessed**
Installation of 277 turbines (125 turbines consented but with the potential for up to 140 turbines as per conditions)	Dredging for GBS bed preparation. Drill arisings from jacket pin pile installation.
Inter array and transmission cable burial	Energetic trenching tool, 'V' shaped trench 3m wide and up to 3m deep, 100% resuspension.
Sediment accumulation and change of sediment type at the seabed	
Installation of 277 turbines (125 turbines consented but with the potential for up to 140 turbines as per conditions)	Dredging for GBS bed preparation. Drill arisings from jacket pin pile installation.
Changes to the Sediment Transport Regime	
Installation of 277 turbines (125 turbines consented but with the potential for up to 140 turbines as per conditions)	60 m diameter GBS
Scour Effects	
Installation of 277 turbines (125 turbines consented but with the potential for up to 140 turbines as per conditions)	60 m diameter GBS

Western Development Area

3.1.3.13 The WDA comprises part of the MORL zone. The three consented windfarms (Telford, Stevenson and MacColl) are located within the Eastern Development Area of the MORL zone. The maximum capacity which could be installed in the entire MORL zone is 1.5 GW.

3.1.3.14 The WDA may be developed for a maximum of 500 MW of capacity subject always to the overall cap of 1.5 GW for the MORL zone. In total the consented capacity of the modified Project and the WDA will not exceed 1.5 GW.

3.1.3.15 The connection between the WDA and the three consented wind farms necessitates a slightly different approach to assessment, as the effects arising from the "worst case" for the modified Project cannot simply be added to the "worst case" scenario for the WDA. Instead, assessment of the likely significant cumulative effects of the modified Project and the WDA will therefore follow a similar format to that undertaken for the sensitivity assessments of the individual wind farm proposals in the Offshore Generating Station Impact Assessment chapters of the MORL ES (MORL, 2012).

3.1.3.16 The total capacity of the MORL zone is capped at 1.5 GW and so the additional placement of 100 x 5MW turbines in the WDA would be offset by an equivalent reduction in the number of turbines elsewhere in the zone.

3.1.3.17 The number of turbines actually consented for the EDA is much smaller (186 to be built instead of 339 assessed as the realistic worst case). As the foundation type and dimensions are not changed, the number of occurrences and so total duration of individual impacts, and array scale effects, will therefore be proportionally reduced to between approximately 55-62% of the previously assessed values.

3.1.3.18 The worst case parameters for the WDA as previously assessed in terms of the wave climate and tidal regime are provided below in Table 3.1-10.

Table 3.1-10 Summary of MORL WDA Worst Case Parameters (as previously assessed but with commentary on consented parameters)

Previously Assessed Realistic Worst Case Parameters	**Scenario Previously Assessed**
Changes to the Tidal Regime	
Installation of 139 turbines in the WDA in conjunction with 200 in the three consented wind farms (186 turbines consented in the three wind farms)	65 m diameter GBS
Changes to the Wave Regime	
Installation of 139 turbines in the WDA in conjunction with 200 in the three consented wind farms (186 turbines consented in the three wind farms)	65 m diameter GBS
Increase in Suspended Sediment Concentrations	
Installation of 139 turbines in the WDA in conjunction with 200 in the three consented wind farms (186 turbines consented in the three wind farms)	Dredging for GBS bed preparation. Drill arisings from jacket pin pile installation.
Sediment accumulation and change of sediment type at the seabed	
Installation of 139 turbines in the WDA in conjunction with 200 in the three consented wind farms (186 turbines consented in the three wind farms)	Dredging for GBS bed preparation. Drill arisings from jacket pin pile installation.
Changes to the Sediment Transport Regime	
Installation of 139 turbines in the WDA in conjunction with 200 in the three consented wind farms (186 turbines consented in the three wind farms)	65 m diameter GBS
Scour Effects	
Installation of 139 turbines in the WDA in conjunction with 200 in the three consented wind farms (186 turbines consented in the three wind farms)	65 m diameter GBS

Cumulative Assessment

3.1.3.19 The types of effects considered in this assessment are:

- Changes to the tidal regime;
- Changes to the wave regime;
- Increase in SSC;

- Sediment accumulation and change of sediment type at the seabed;
- Changes to the sediment transport regime; and
- Scour effects.

3.1.3.20 The receptors identified for consideration in this cumulative assessment are:

- The Smith Bank;
- Seabed along the offshore export cable route;
- Designated coastal habitats; and
- Recreational surfing venues.

Construction

3.1.3.21 This section considers the cumulative effects of the combined modified OfTI and the three consented wind farms – i.e. the whole Project; and the whole Project with all other developments on hydrodynamic, sedimentary and coastal processes during the construction phase. More details of this assessment may be found in MORL (2012); Appendix 3.4 C: Metocean and Coastal Processes Impact Assessment.

Changes to the Tidal and Wave Regimes

3.1.3.22 Prior to the installation of wind farms or offshore transmission infrastructure, there is no potential for any significant modification to the baseline wave and tidal regimes. The worst case scenarios of all wind farm infrastructure installed during the operational phase is considered in the following section. The effect of less than the total amount of infrastructure at an intermediate stage in the construction process is (generally proportionally) less than that reported in the following section for the operational phase of the combined wind farm developments. <u>Therefore, these effects are not considered explicitly during the construction phase.</u>

Increases in Suspended Sediment Concentrations and Changes in Sediment Type/Thickness at the Seabed
<u>Modified OfTI and Telford, Stevenson and MacColl wind farms</u>
<u>*Sensitive Receptor: The Smith Bank*</u>

3.1.3.23 Cumulative effects of multiple and simultaneous sources of sediment release may potentially arise due to simultaneous pin-pile drilling, bed preparation activities and/or cable installation.

3.1.3.24 With regards to increases in suspended sediment concentrations, an impact assessment has previously been carried out for the individual sources of sediment release considered for the modified OfTI (Section 3.1.2) and for the three consented wind farms in the MORL ES (MORL, 2012; Chapters 6.1: Hydrodynamics (Wave Climate and Tidal Regime) and 6.2; Sedimentary and Coastal Processes).

3.1.3.25 If foundation installation activities occur simultaneously at multiple adjacent locations, there is a potential that plumes of increased SSC will interact. The maximum cumulative result of interaction between sediment plumes is an additive increase in SSC.

3.1.3.26 However, given the minimum spacing of the turbines and the width of the plume, if the adjacent locations are not aligned along the direction of the tidal current, there is no potential for the plumes to interact. If the adjacent locations are aligned to the tidal axis, turbine foundations are located a minimum of 600 m (crosswind) or 840 m (downwind) apart so the downstream level of SSC in the sediment plume from the upstream source will have decreased to 20 mg/l or less. At most, this may cause the levels of SSC adjacent to the downstream source to increase from 30-40 mg/l, to 50-60 mg/l. The SSC level of the more disperse effects (1- 5 mg/l) outside of the main plume during operations and in the area of plume following cessation of operations are unlikely to be changed as a result of cumulative effects.

3.1.3.27 Locally within the wind farms, foundation installation will likely be completed before cables are laid. The majority of the export cable route is too far from the wind farms for an overlap in sediment plumes to occur. For operational safety, it is also unlikely that cables will be simultaneously buried less than 10s of metres from each other or from any other operation. Therefore, only the low-level dispersal effects from dredging or drilling activities (order of 1-5 mg/l) have the potential to combine with the higher magnitude local effects of cable burial (1,000s to 10,000s of mg/l). Therefore, there is no potential for (measurable) cumulative interaction between cable burial and foundation installation activities.

3.1.3.28 The cumulative effects of plume interaction from a variety of sources are of a magnitude consistent with the natural range of variability (order 1,000 to 10,000 mg/l nearbed and order 10 to 100 mg/l higher in the water column). Local effects around cable burial machines may potentially be in excess of the natural range of variability but will also be only localised and temporary.

3.1.3.29 For the whole Project, a small to medium magnitude of change in SSC that may locally and temporarily exceed the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in a temporary negative cumulative effect of **minor significance.**

3.1.3.30 The nature, magnitude, extent, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012).

3.1.3.31 With regards to changes in sediment thickness and type at the seabed, relatively thick (up to several metres) sediment accumulation will occur in the near-field vicinity of foundations where pin piles are installed by drilling. These deposits will be localised and therefore will not coalesce between foundations or between wind farm sites, posing no cumulative effect.

3.1.3.32 The maximum thickness of sediment accumulation in the far-field predicted to result from the three consented wind farms and modified OfTI is less than 1 mm. The effects of dredging as part of bed preparation for GBS foundations in terms of thickness of accumulation are generally of a magnitude consistent with the natural range of variability and so will not affect total water depths. The accumulation of a variable thickness of fine sediment to areas presently indicated to be mostly sands or sandy-gravels outside of the combined wind farm developments may temporarily change the sediment surface texture in that area; however, these fine sediment accumulations are expected to be reworked and dispersed to background concentrations by storms on short to medium time-scales.

3.1.3.33 A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. The resulting cumulative effect in relation to sediment type and thickness is therefore of **minor significance**.

3.1.3.34 For the whole Project including modified OfTI, the nature, magnitude and significance of the predicted potential cumulative effects are the same as previously assessed for the original whole Project in the MORL ES (MORL, 2012). The duration and extent of the predicted potential effect are however reduced, due to the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed

Total Cumulative Impact (All Developments)

3.1.3.35 The potential for cumulative impacts with the BOWL development and WDA is considered to be limited, with a small to medium magnitude of change in SSC / bed thickness that may locally and temporarily exceed the range of natural variability anticipated to arise in areas of low sensitivity. The total cumulative effect will therefore remain very similar to that assigned to the cumulative assessment of the modified OfTI and Telford, Stevenson and MacColl wind farms (i.e. **minor significance**).

Disturbance of Coastal Morphology at the Landfall Site

3.1.3.36 No potential for cumulative impacts on coastal morphology at the landfall have been identified. The effect therefore remains of **negligible significance** and not significant in terms of the EIA Regulations.

Operation

Changes to the Tidal Regime

Modified OfTI and Telford, Stevenson and MacColl Wind Farms
Sensitive Receptor: The Smith Bank

3.1.3.37 Using GBS or jacket foundations for all turbines in the combined modified OfTI and wind farm developments will have no measurable effect on tidal water levels or tidal current directions. Using jacket foundations for turbines will also have no measurable effect on tidal current speed.

3.1.3.38 Using GBS foundations for all turbines will only have a (nearly) measurable effect on tidal currents during spring tidal periods. The main effect is a phase shift, simply advancing the current peak in time by 5-10 minutes. The peak flow speed in the region of the wind farms will also be reduced by approximately 0.03 m/s (not a measurable effect). Given the similarity in the controlling physical processes, a similarly low order of effect on non-tidal (surge) water levels is inferred.

3.1.3.39 The relative contribution of the two jacket foundations for the OSPs is negligible, approximately 0.3% of the (not measureable) total effect of using jacket foundations for all turbines.

3.1.3.40 The effects of the combined modified OfTI and wind farm developments on water levels and currents will persist for the operational lifetime of the developments. However, they are of very low magnitude, have only a local effect and do not directly affect any of the identified sensitive physical environmental receptors beyond the range of natural variability.

3.1.3.41 A small magnitude of change within the range of natural variability is therefore assessed to arise in an area of low sensitivity resulting in an effect of **minor significance**.

3.1.3.42 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Sensitive Receptor: Designated Coastal Habitats

3.1.3.43 No measurable effect on the tidal regime is predicted to occur further than one tidal excursion (order of 7 km) outside of the extent of the combined modified OfTI and wind farm developments.

3.1.3.44 A small magnitude of change within the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in an effect of **minor significance**.

3.1.3.45 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed

Sensitive Receptor: Stratification Fronts

3.1.3.46 No measurable effect on the tidal regime is predicted to occur further than one tidal excursion (order of 7 km) outside of wind farms. As these features are the product of regional fresh water/saline patterns (unaffected by the combined wind farm developments) and the tidal regime (water depth and current speed), there will be no consequential effect on the strength or location of stratification fronts.

3.1.3.47 A small magnitude of change within the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in an effect of **minor significance**.

3.1.3.48 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Total Cumulative Impact (all developments)

3.1.3.49 The potential for cumulative impacts with the BOWL development and WDA is considered to be limited, with a small magnitude of change anticipated to occur but within the range of natural variability in areas of low sensitivity. The total cumulative effect will therefore remain very similar to that assigned to the cumulative assessment of the Modified OfTI and Telford, Stevenson and MacColl wind farms (i.e. **minor significance**).

Changes to the Wave Regime

Modified OfTI and Telford, Stevenson and MacColl wind farms

Sensitive Receptor: The Smith Bank

3.1.3.50 Wave conditions naturally vary from calm conditions to maximum wave heights of 4-9 m depending upon the strength of the wind and its direction; further natural variability in the order of 10% is also expected on the basis of historical trends and the generally predicted effects of climate change.

3.1.3.51 In relation to wave height and period, it was previously shown in MORL (2012) that when using jacket foundations for all wind turbines in the cumulative developments:

- Jacket foundations do not measurably affect wave height or period, i.e. differences in significant wave height are <0.1 m (1.5%) and in wave period are <0.1 s (1- 1.5%) in the near-field (and even less in the far-field).

3.1.3.52 And when using GBS foundations for all wind turbines in the cumulative developments:

- The maximum reduction in wave height within the consented wind farm areas varies between 0.4-1.6 m or 6-24% of the incident wave height (which varies between 4-9 m) for all directions and return periods. The greatest absolute effects are on the largest waves (i.e. from 90°N). The greatest absolute and proportional effects are for the largest waves passing through the longest axis of the combined sites (i.e. from 45-90°N) the smallest proportional effects are on waves from 270°N.

3.1.3.53 The relative contribution of the two jacket foundations for the OSPs is negligible: it is approximately 0.3% of the (already not measureable) total effect of using jacket foundations for all turbines.

3.1.3.54 A small magnitude of change, typically within the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in an effect of **minor significance**.

3.1.3.55 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

<u>*Sensitive Receptor: Designated Coastal Habitats*</u>

3.1.3.56 In relation to wave height and period outside of the consented wind farm areas, it was previously shown in MORL (2012) that when using jacket foundations for all wind turbines in the cumulative developments:

- Jacket foundations do not affect waves by more than 0.05 m (1%) significant wave height or 0.1 s (1-1.5%) wave period in the far-field.

3.1.3.57 When using GBS foundations for all wind turbines in the cumulative developments:

- When the combined wind farm developments are present, the maximum magnitude of effect on wave height for the following designated sites are:
    - o East Caithness Cliffs SPA: of the order 0.4-0.5 m (4-5% of the incident wave condition) for waves from the east or south east (occurring 29% of the time), of the order 0.2-0.3 m (2-3% of the incident wave condition) for waves from the north east or south (41.4% of the time) and <0.1 m (1% of the incident wave condition) for other directions (29.6% of the time);
    - o Moray Firth SAC and open Coastal Sites: of the order 0.1-0.2 m (2-3% of the incident wave condition) for waves from the north, north east or east (54% of the time) and <0.1 m (up to 2% of the incident wave condition) for other directions (46% of the time); and

- Inner Moray Firth and enclosed water bodies: <0.05 m (<1% of the incident wave condition, i.e. no measurable effect) for all wave coming directions.

3.1.3.58 The relative contribution of the two jacket foundations for the OSPs is negligible, approximately 0.3% of the (already not measureable) total effect of using jacket foundations for all turbines.

3.1.3.59 A medium magnitude of change but within the range of natural variability is therefore assessed to arise in areas of low sensitivity and a small magnitude of change within the range of natural variability is also assessed to arise in areas of potentially medium sensitivity. The resulting effect is of **minor significance**.

3.1.3.60 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Sensitive Receptor: Recreational Surfing Venues

3.1.3.61 This assessment of likely significant effects to the wave regime is based upon the analysis of wave model results with and without GBS present in the combined wind farm developments over a two year period (see MORL, 2012; chapter 13.1 for details) Time series of wave conditions have been extracted from the model results immediately offshore of the identified surfing beaches in the vicinity of the modified OfTI. The same statistical and frequency analysis has been applied to each data set to obtain baseline values and the difference in the frequency of occurrence of key event types resulting from the presence of the combined wind farm developments.

3.1.3.62 Considering the cumulative effects of the combined wind farm developments, GBS foundations were found to have no effect >0.01 m wave height or >0.1 s wave period at eight out of eighteen venues. Of the remaining ten venues, effects were typically limited to a 0.02-0.09 m decrease in wave height (only one site, Lossiemouth, was higher at 0.14 m), but no effect on wave period or the frequency of occurrence of any representative conditions. The relative contribution of the two jacket foundations for the OSPs is negligible in comparison to the effects described above associated with the consented wind farm areas.

3.1.3.63 A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity, resulting in an effect of **minor significance**.

3.1.3.64 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Total Cumulative Impact (all developments)

3.1.3.65 The potential for cumulative impacts with the BOWL development and WDA is considered to be limited, with a medium magnitude of change (but within the range of natural variability) anticipated to arise in areas of low sensitivity and a small magnitude of change anticipated to arise in areas of potentially medium sensitivity.

The total cumulative effect will therefore remain very similar to that assigned to the cumulative assessment of the Modified OfTI and Telford, Stevenson and MacColl wind farms (i.e. **minor significance**).

Changes to the Sediment Transport Regime
Modified OfTI and Telford, Stevenson and MacColl wind farms
Sensitive Receptor: The Smith Bank

3.1.3.66 It is the combined wave and tidal regimes that ultimately control sediment transport and therefore the seabed form and function on the Smith Bank. It was shown in the MORL ES (MORL, 2012, Section 13.1) that the cumulative effect of the combined wind farm developments causes no significant change to the speed or directions of tidal currents, irrespective of the foundation type used. It was also shown that GBS foundations will cause a reduction in instantaneous significant wave height within the combined wind farm developments of up to 21% (but more typically 10% or less across most of the site area) and up to 5% in the far-field. The maximum magnitude of effect on waves is therefore of the same order as natural inter-annual and inter-decadal variability in storm intensity. Using jacket foundations for the turbine foundations will have little or no measurable effect (< 1%) on wave height. Using GBS or Jacket foundations will not measurably affect wave period or direction.

3.1.3.67 Given no significant effect on the physical processes that control it, there can be no corresponding effect on potential rates and directions of sediment transport through the combined wind farm developments.

3.1.3.68 The MORL ES (MORL, 2012, Section 13.1) considered the potential for the construction of the wind farm to affect the character or abundance of surface sediments (e.g. as a result of ground preparation, drilling or inter-array cable burial activities) and found it to be not significant. Whilst some short to medium-term localised increases in sediment thickness are expected, there is not expected to be a significant change in the textural properties or quantity of the sediment available for transport. This supports the further conclusion that actual sediment transport rates through the combined wind farm developments will not be affected by the planned development.

3.1.3.69 The worst case effect of a reduction in wave height on sediment transport pathways and resulting morphology in the combined wind farm developments is:

- The area within the combined wind farm developments may tend to accumulate sediment at a slightly higher rate than would have otherwise occurred during the operational lifetime of the development; and
- The supply of sediment to areas located further into the Moray Firth might be slightly less than would have otherwise occurred during the operational lifetime of the development.

3.1.3.70 However, as stated above, the absolute difference in sediment transport attributable to the wind farm is less than the potential for natural variability over the same period.

3.1.3.71 There will, therefore, be no effect on the form or function of the Smith Bank.

3.1.3.72 A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity resulting in an effect of **minor significance**.

3.1.3.73 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are

3 Human Environment

3.3 Onshore Noise

3.3.1 Baseline Information

Introduction

3.3.1.1 This section considers the baseline against which construction, operation and decommissioning effects have been compared to assess the significance of the noise in EIA terms. A noise technical report is presented in Appendix 3.3 A which presents further details in relation to the baseline environment within the modified onshore export cable corridor and indicative substation locations whilst the baseline noise survey data is presented in Appendix 3.3 A: Noise Technical Report. Appendix 3.3 A (App 2) presents noise levels tables for each assessed construction scenario at varying distances from the works area within the modified onshore export cable corridor and indicative substation locations.

3.3.1.2 Potentially sensitive receptors to noise include residential properties, which are generally located within a predominantly rural location (with the exception of properties located within the urban area of Banff) where existing baseline noise levels are generally relatively low at locations away from main roads. Schools located within the wider study area have also been considered.

3.3.1.3 Potentially sensitive receptors to noise include residential properties, which are generally located within a predominantly rural location (with the exception of properties located within the urban area of Banff) where existing baseline noise levels are generally relatively low at locations away from main roads. Schools located within the wider study area have also been considered.

Consultations

3.3.1.4 Details of consultation undertaken with the Aberdeenshire Council is presented in Table 3.3-1.

Table 3.3-1 Consultation

Organisation	Consultation Response	MORL Approach
Environmental Health Department, Aberdeenshire Council	Consultation has been undertaken between Sam Moran (WYG) and Linda Will, Environmental Health Officer, Aberdeenshire Council by telephone conversation on 27th May 2014. It was specified by Linda Will that the assessment methodology to be undertaken within the ES is in line with the proposed methodology presented within the MORL TI Scoping Report (MORL, 2014).	The assessment has been undertaken in accordance with the agreed methodology (as shown in Appendix 3.3 A) with the exception that the noise survey was completed over a marginally shorter timeframe, although data has still been collected during a variety of weather conditions. Details of the noise survey can be found in Section 4 of the Noise Technical Report and in Appendix 3.3 A (App 2).
	Regarding the operational noise assessment, Linda Will requested that consideration was given to Noise Rating (NR) levels with respect to establishing the internal noise level criteria at receptors within proximity to the substations.	Consideration has been given to NR levels, details of this assessment can be found in section 5 of Technical Appendix 3.3 A: Noise Technical Report.

Baseline Characteristics

3.3.1.5 The route of the modified OnTI runs through mainly rural areas and passes a number of towns /villages such as Cuminestown and Banff. The route is shown in Figure 3.3-1 In Volume 3.

Desktop Studies

3.3.1.6 In addition to on site observations made during the noise survey, a desk based review of Ordnance Survey (OS) landline information, electoral registers and Google satellite images has been undertaken to identify the location of sensitive receptors which are detailed in the noise technical report.

Baseline Noise Environment

3.3.1.7 In order to define the baseline noise environment along the modified OnTI route, an extensive noise survey has been undertaken at locations representing sensitive receptors around the modified onshore export cable route corridor and indicative substation locations (See Figure 3.3-1 in Volume 3) The measurements include attended and unattended measurements which have been collected during both daytime and night-time periods over weekdays and weekends at 52 survey locations. The noise survey data is tabulated in Appendix 3.3 A(App 2) with further details regarding the survey presented within the noise technical report in Appendix 3.3 A. Noise levels are primarily influenced by traffic noise, livestock, birdsong and wind induced vegetation noise. Noise levels generally fall to very low levels at night in locations away from roads.

Site Specific Surveys

3.3.1.8 A baseline monitoring survey was undertaken at 52 locations (as specified in the following table and shown in Figure 3.3-1 in Volume 3) from 17th May 2014 to 29th May 2014. Attended short term measurements were undertaken at 11 locations during daytime periods on both weekdays and weekends, with 41 additional locations being measured unattended; the results of the baseline survey are summarised in Appendix 3.3 A (App 2), the raw data collected from the long term monitoring is available upon request.

3.3.1.9 The short term locations where chosen to represent properties that were not covered by the unattended measurements and as a safeguard in the event of complaints.

Legislative and Planning Framework

3.3.1.10 Noise from wind farm developments is considered within Sections 187 - 192 of Scottish Planning Policy (2010) which states that 'the criteria will vary depending on the scale of development and its relationship to the characteristics of the surrounding area'. With regard to off-shore developments, plans should identify appropriate locations for infrastructure facilities.

3.3.1.11 There are local policies regarding noise or vibration within the Aberdeenshire Local Development Plan 2012 which states "Renewable energy development could potentially have an impact on occupiers of neighbouring properties, such as noise, visual intrusion or traffic movements. The developer should demonstrate that satisfactory steps have been taken to mitigate negative development impacts" (Aberdeenshire Council Local Development Plan 2012: Supplementary Guidance Rural Development 3: Other renewable energy developments).

3.3.1.12 The Control of Pollution Act 1974 provides a framework for applying (under section 61) for a 'prior consent for work on construction sites' allowing noise levels and construction methods to be agreed with Aberdeenshire Council.

Planning Advice Note 1/2011: Planning and Noise

3.3.1.13 This Planning Advice Note (PAN) provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. It provides high level guidance on issues such as development planning, development management, noise impact assessment and mitigation. The PAN refers to Technical Advice Note (TAN): Assessment of Noise for more detailed guidance with respect to noise assessments.

Technical Advice Note (TAN): Assessment of Noise (March 3, 2011)

3.3.1.14 The TAN presents guidance on using a five stage assessment approach from identifying sensitive receptors to determining the level of significance of a proposed in order to inform the decision process. This guidance has been used in establishing the assessment methodology within this Chapter.

3.3.2 Impact Assessment

Summary of Effects and Mitigation

3.3.1.15 A summary of effects and mitigation is presented in Table 3.3-2 below.

Table 3.3-2 Impact Assessment Summary

Effect	Receptor	Pre-mitigation Effect	Mitigation	Post-mitigation Effect
Construction & Decommissioning – Modified OnTI				
Noise	141 Sensitive Receptor Locations	Negligible during daytime, up to significant if during evening or night-time	Detailed in Section 1.1.2.9 No night time working.	Negligible.
Vibration	141 Sensitive Receptor Locations	None	None Required	None
Operational Noise (Substation)				
Noise	13 Sensitive Receptor Locations	Will be designed to be neutral effect	No additional required	Will be designed to be neutral effect

Summary of Effects – Operational Noise (Substations)

3.3.1.16 During the operational phase, noise will be generated by plant associated with the substations. At this stage of the proposals, specific details of the exact location of these noise sources are not available. However, an indicative worst case scenario assessment has been undertaken to identify potential noise levels at the closest receptors to five worst case indicative substation locations (shown in Figure 3.3-3 in Volume 3). The assessment has identified that at the nearest potential location, the maximum reduction in noise levels required by the substation building/enclosures would need to be 23.3 dB. Typical substation building/enclosure constructions have been considered and show that a 25 – 30 dB reduction will be readily achievable. The buildings and enclosures will be designed to meet the relevant BS8233:2014 (Guidance on sound insulation and noise reduction for buildings) target external and internal noise levels at all nearby sensitive receptor locations and as such there will be no residual effects.

3.3.1.17 The assessment has determined that there will be no operational vibration effects associated with the proposed scheme.

Summary of Effects – Modified OnTI Construction

3.3.1.18 In accordance with the 'significance based upon noise change' ABC method of assessment outlined in BS 5228-1:2009 (Code of practice for noise and vibration control on construction and open sites), a significant effect is deemed to occur if the total noise level exceeds the threshold level for the category appropriate to the ambient noise level. It can be seen from the results detailed in section 3 of the Noise Technical Report (Appendix 3.3 A) that no properties are expected to receive a significant effect during the daytime.

3.3.1.19 The OnTI works will be temporary, of a short term duration and mostly undertaken during standard daytime working hours, Monday to Saturday. However, there is the possibility that due to operational requirements a small amount of construction work will be required outside of these hours and potentially during the night-time period.

3.3.1.20 The assessment detailed in the Noise Technical Report (see Appendix 3.3 A) confirms that there could be significant noise effects at some properties in the event of evening or night-time working. Night time construction activities will therefore be avoided at all sensitive locations.

3.3.1.21 Noise from Heavy Goods Vehicle (HGV) movements on the public highway has been assessed. There are no significant effects at sensitive receptors (some of which are adjacent to the public highway)during the daytime. There are no proposed HGV movements during the evening or night-time.

Proposed Mitigation Measures and Residual Effects

Operational Phase

3.3.1.22 The buildings and enclosures will be designed to meet the relevant BS8233:2014 target external and internal noise levels at all nearby sensitive receptor locations and as such there will be no residual effects. The requirement to achieve this criteria can be enforced through the use of suitably worded planning conditions.

Modified OnTI Construction

3.3.1.23 During the construction phase, through the use of 'Best practice' noise control measures outlined in Section 8.5 of BS 5228:2009 (Code of practice for noise and vibration control on construction and open sites), and the restriction of working hours such as at evenings and weekends, noise effects can be reduced and the assessment shows that significant effects are not likely to occur.

Introduction to Impact Assessment

3.3.1.24 The methodology used to assess the likely effects during the construction, operational and decommissioning phases has been defined within the context of planning policy and guidance. Effects which are significant have been established and, where required, mitigation measures have been specified. The residual effects have then been stated.

Details of Impact Assessment

3.3.1.25 With respect to noise assessments in Scotland, the principal planning advice and guidance is contained within Planning Advice Note 1/2011: Planning and Noise and Technical Advice Note (TAN): Assessment of Noise. In addition, with regard to noise sources of an industrial nature, BS 4142 'Rating Industrial Noise Affecting Mixed Residential and Industrial Areas' (1997) is typically regarded as the most appropriate assessment method.

3.3.1.26 BS 4142 states that the standard is unsuitable when background noise levels and noise rating levels L_{Aeq} are very low. The documents clarifies that a background noise level of around 30 dB and a noise rating level of around 35 dBL_{Aeq} are very low; measured background noise levels at residential locations surrounding the proposed substation locations are considered to be very low (around or below 30 dB L_{A90}). Accordingly, rather than adopting the 5 stage approach outlined within the TAN, the assessment is based on achieving an external noise rating level of 35 $dBL_{Aeq,1hour}$ at the nearest sensitive receptors.

3.3.1.27 Noise from potential construction activity has been assessed in accordance with BS 5228-1: 2009 '*Code of Practice for Noise and vibration control on construction and open sites*' which provides guidance on the prediction, measurement and assessment of noise generated from construction sites as follows. In order to determine whether construction noise levels are significant or not, reference has been made to the fixed limit and ABC methods provided in Annex E.2 of BS 5228-1:2009.

3.3.1.28 In accordance with the principles outlined in BS 4142:1997, BS 8233:2014 and BS 5228:2009 methodologies, the criteria which the noise impact during the construction and operational have been assessed against have been established following the review of the baseline noise data collected during the noise survey. During construction, the assessment has considered receptors along and adjacent to the modified OnTI whilst the operational assessment considers only the area around the indicative substation locations (See Figures 3.3-2 and 3.3-3 in Volume 3).

Rochdale Envelope Parameters Considered in the Assessment

3.3.1.29 The Rochdale Envelope considers all the potential modified OnTI parameters and scenarios, the details of which are presented in Chapter 2.2: Project Description. The potential for noise and vibration effects during the construction, operation and decommissioning phases of the modified OnTI are based upon the 'realistic worst case scenario' indicated in the design envelope and are specific to the potential effects assessed in this Chapter. The design envelope parameters considered within the assessment are presented in the Table below (Table 3.3-3).

Table 3.3-3 Rochdale Envelope Parameters relevant to the Noise and Vibration Impact Assessment

Potential Effect	**Rochdale Envelope Scenario Assessed**
Construction & Decommissioning	
Site Preparation and Construction Noise	Given the cable corridor, receptors within 1 km of the corridor have been assessed using realistic worst case 1 hour construction noise levels. Receptors within 1km are those that have the potential to be around or above background noise levels. The modified export cable Landfall / modified onshore export cable route corridor / indicative location of onshore substations has been assessed.
Noise from HGV movements	In the absence of exact locations of HGV movements, the HGV movements based on data provided in table 5.6-5 of Chapter 5.6 (transport) have been assessed.
Vibration	Although the precise locations of piling (if any) are not known, only daytime sheet piling at a small number of locations will be undertaken during the construction phase. However it is known that there is no cable percussive piling proposed and no piling at night.
Operation	
Noise	The noise assessment has considered potential plant locations within five indicative locations on the site of the onshore substations shown in Figure 3.3.3 in Volume 3. Closest sensitive properties (up to 1km) to the five worst case indicative locations of the substations have been considered. Beyond this distance worst case predicted operational noise levels would be below background noise levels.

EIA Methodology

3.3.1.30 A 'significance matrix assessment approach' which is based on the characteristics of the effect (magnitude and nature) and the sensitivity of the receptor has been set out below. This allows the relative significance of effects to be assessed on a scale and ultimately the significant effects determined, as explained in the following subsections. The derivation of the significance of effects follows stages 1 – 4 as presented in the TAN (Technical Advice Note (TAN): Assessment of Noise (March 3, 2011) to derive the descriptors and assessment criteria. It should be noted, however, that the overarching method which has been adopted as part of this assessment, using the most appropriate guidance, is based on establishing whether the effects of the modified OnTI are significant or not in EIA terms within the context of absolute noise level criteria. This approach incorporates the matrix based approach with the TAN stages as identified below.

Stage 1 – Initial Process

3.3.1.31 Key receptors to noise include individual or groups of residential properties, hospitals and schools. Table 3.3-4 provides examples of the different sensitivities which can be assigned to different receptors.

Table 3.3-4 Method for Assessing the Sensitivity Associated with Various Examples of Noise Sensitive Receptors

Sensitivity	Description	Receptor
High	Receptors where people or operations are particularly susceptible to noise	Residential, including private gardens where appropriate Quiet outdoor areas used for recreation Conference facilities Theatres/Auditoria/Studios Schools during the daytime Hospitals/residential care homes Places of worship
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	Offices Bars/Cafes/Restaurants where external noise may be intrusive Sports grounds when spectator noise is not a normal part of the event and where quiet conditions are necessary (e.g. tennis, golf, bowls)
Low	Receptors where distraction or disturbance from noise is minimal	Buildings not occupied during working hours Factories and working environments with existing high noise levels Sports grounds when spectator noise is a normal part of the event Night Clubs

Stage 2 – Quantitative Assessment

3.3.1.32 Table 3.3-5 presents the descriptors and corresponding general criteria which provide a classification of the magnitude of noise effects. The table also identifies a method of assessing the magnitude of effect in terms of the change in noise level as a result of the proposed development.

Table 3.3-5 Classification of Magnitude on Noise Effects

Descriptors for Magnitude of Effect	Criteria of Descriptor and Change in Noise Level Effect / Change in Noise Level, dB
Major	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements. Greater than +5 dB
Moderate	Loss of resource, but not adversely affecting the integrity; partial loss of / damage to key characteristics, features or elements. From +3 dB to + 5 dB
Minor	Some measurable change in attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. From +1 dB to + 3 dB
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements. From 0 dB to + 1 dB
No Change	No loss or alteration of characteristics, features or elements; no observable impact in either direction.

3.3.1.33 Further to the general classification presented in Table 3.3-5, for the purpose of this assessment there is the requirement to consider establishing descriptors which are specific to a particular source of noise.

3.3.1.34 BS 5228: 2009+A1 2014 - "Code of practice for noise and vibration control on construction and open sites" sets out a methodology for predicting, assessing and controlling noise and vibration during construction works. An example method to define the significance of the potential construction noise effects is the 'significance based upon noise change method' presented within Annex E of BS 5228-1:2009. This is explained in Stage 4 below and establishes the significance of noise effects.

3.3.1.35 With respect to a source which is industrial in nature, such as mechanised plant associated with the substations, the most relevant guidance is BS 4142:1997 'Rating Industrial Noise Affecting Mixed Residential and Industrial Areas' (1997).

3.3.1.36 In addition to noise levels the likelihood of complaints depends on the individuals affected and to the acoustic features present. Section 8 of BS 4142:1997 recommends that a correction factor of +5dB be applied to the specific noise level if the noise contains certain acoustic features that can increase the likelihood of complaints. Such features of new or modified noise sources include:

- a distinguishable, discrete, continuous note (whine, hiss, screech, hum etc.)
- distinct impulses (bangs, clicks, clatters or thumps)
- irregular enough to attract attention.

3.3.1.37 As specified within the MORL TI Scoping Report (MORL, 2014), due to the rural nature of the area where the indicative substations are located, existing background noise levels will be low. BS 4142:1997 specifies that the method is not suitable for assessing noise measured inside buildings or when the background noise level and rating level are very low. For the purpose of the standard, background noise levels below around 30 dB and rating levels below around 35 dB are considered to be very low. The baseline noise survey shows that during both daytime and night-time periods very low noise levels exist within the modified OnTI area. As such, measured background noise levels determine that the assessment area falls outside of the scope of BS 4142:1997.

Stage 3 – Qualitative Assessment

3.3.1.38 Where the quantitative assessment does not provide sufficient information on noise effects or where attributing a descriptor is over simplistic, a qualitative assessment can be used to assist in the determination of the significance of effect.

3.3.1.39 This stage is based on perception and how noticeable the noise effect is in affecting the amenity value of the noise-sensitive receptor. In order for a qualitative assessment to assist in supporting or modifying the outcome reached from the quantitative assessment, descriptors for the qualitative effects that correspond with those used for assessing the magnitude of effects need to be assigned. This is presented in Table 3.3-6 below.

Table 3.3-6 Example of Assigning Descriptors for Qualitative Effects from Noise on Sensitive Properties

Perception	Criteria of Descriptor for Residential Dwellings	Descriptor for Qualitative Impact
Noticeable **(Very disruptive)**	Significant changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm.	Major significance
Noticeable **(Disruptive)**	Causes an important change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in character of the area.	Moderate significance
Noticeable **(Mildly Intrusive)**	Noise can be heard and may cause small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; closing windows more often. Potential for non-awakening sleep disturbance. Can slightly affect the character of the area but not such that there is a perceived change in the quality of life.	Minor significance
Just Noticeable **(Non intrusive)**	Noise can be heard, but does not cause any change in behaviour or attitude, e.g. increasing volume of television; speaking more loudly; closing windows. Can slightly affect the character of the area but not such that there is a perceived change in the quality of life.	Negligible
Not Noticeable	None	No Effect

Stage 4 – Level of Significance

3.3.1.40 Table 3.3-7 presents an example of how the interaction of magnitude and sensitivity results in the significance of an environmental effect. If the scale of the effect magnitude is negative then the resulting effect is adverse. If the scale of the effect magnitude is positive then the resulting effect is beneficial.

Table 3.3-7 Example of Assigning Descriptors for Qualitative Effects from Noise on Sensitive Properties

Magnitude of Effect	Sensitivity of Receptor		
	High	**Medium**	**Low**
Major	Large / Very Large	Moderate / Large	Slight / Moderate
Moderate	Moderate / Large	Moderate	Slight
Minor	Slight / Moderate	Slight	Neutral / Slight
Negligible	Slight	Neutral / Slight	Neutral / Slight
No change	Neutral	Neutral	Neutral

3.3.1.41 As stated within the TAN, the level of significance and its relevance to the decision making process is explained as follows:

- Very Large: These effects represent key factors in the decision-making process. They are generally, but not exclusively, associated with effects where mitigation is not practical or would be ineffective.
- Large: These effects are likely to be important considerations but where mitigation may be effectively employed such that resultant adverse effects are likely to have a Moderate or Slight significance.
- Moderate: These effects, if adverse, while important, are not likely to be key decision making issues.
- Slight: These effects may be raised but are unlikely to be of importance in the decision making process.
- Neutral: No effect, not significant, noise need not be considered as a determining factor in the decision making process.

3.3.1.42 This assessment considers the above levels of significance to be synonymous with EIA significance criteria.

Construction Noise

3.3.1.43 With regard to construction effects, the specific assessment methodology used follows the BS 5228-1:2009 ABC Method (E.3.2. Example Method 1). This method is adopted to identify whether the level of construction noise incident at neighbouring residents could be significant. Primarily, the ABC Method requires the ambient noise level for the appropriate period (night, evening/weekends or day) to be determined and rounded to the nearest 5dB. This is then compared with the site noise level and if the site noise level exceeds the appropriate category value, then a significant effect is deemed to potentially occur.

3.3.1.44 However, as these thresholds are primarily relevant with regard to long term large scale road or rail projects, the Stage 3 qualitative assessment will also be used to establish whether the effect is significant in line with the TAN guidance and in EIA terms.

3.3.1.45 Table 3.3-8 below shows the threshold of significant noise effects at dwellings (as defined in BS 5228-1:2009 ABC Method (E.3.2. Example Method 1). In the absence of other specific guidance, it is considered reasonable to consider the effect will be comparable at other receptors of high sensitivity. In EIA terms, for the purpose of this assessment, if the predicted noise level falls on or below the relevant threshold presented in Table 3.3-8, the effect will not be significant whilst an effect will be significant if it exceeds the threshold. The Stage 3 Qualitative assessment will be referred to in determining the residual effect.

Table 3.3-8 Matrix for Determining Threshold of Potentially Significant Construction Noise Effects (from BS 5228-1:2009)

Assessment category and threshold value period (LAeq) [Average A-Weighted Noise Levels]	Threshold value in decibels (dB)		
	Category A A)	Category B B)	Category C C)
Night (23:00 – 07:00)	45	50	55
Evenings and Weekends D)	55	60	65
Day (07:00 – 19:00) and Saturdays (07:00 / 13:00)	65	70	75

Note 1: A significant effect has been deemed to occur if the L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.

Note 2: If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise is higher than the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to construction activity.

Note 3: Applied to residential receptors only.

A) Category A: threshold values to use when the ambient noise levels (when rounded to the nearest 5dB) are less than these values.
B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.
D) 19.00-2300 weekdays, 13.00-2300 Saturdays and 07.00-2300 Sundays

Industrial Noise

3.3.1.46 Due to the very low existing background noise levels, the noise criteria presented within BS 8233:2014 'Sound insulation and noise reduction for buildings – code of practice' and World Health Organisation (WHO) recommendations presented within their 'Guidelines for Community Noise' (1999) publication have been used. In addition to the guidance provided within BS 8233:2014 and the WHO Guidelines, further consideration has been given to NR curves which are considered to be another way of demonstrating acceptable levels in noise sensitive premises whilst taking into account the anticipated tonal content of the noise generation.

3.3.1.47 For the purpose of this assessment the target noise criteria (based on BS 8233:2014) will be applied:

- Internal noise levels in bedrooms: 25 $dBL_{Aeq,5\ mins}$ / NR 20
- Internal noise levels in living rooms: 30 $dBL_{Aeq,1\ hour}$ / NR 25
- Noise levels in external amenity areas: 35 $dBL_{Aeq,1\ hour}$ / NR 25

3.3.1.48 In EIA terms, for the purpose of this assessment, if the predicted noise level falls on or below the NR criteria specified in the bullet points above, the effect will not be significant whilst an effect will be significant if it exceeds the criteria.

Limitations of the Assessment

3.3.1.49 With regard to construction works, the detailed design work has not yet been commissioned. Where such details are unknown, the assessment undertaken has been based on a worst case scenario informed by previous experience and professional judgement of the assessor with regard to similar types of development or source noise data for similar applications which is available within the public domain.

3.3.1.50 The assessment undertaken provides sufficient information to enable the Local Planning Authority to adequately assess the likely effects of the modified OnTI for all identified sources of noise during the construction, operational and decommissioning phases.

Impact Assessment

Operational Noise (Substation)

3.3.1.51 During the operational phase, noise will be generated by plant associated with the substations. At this stage of the proposals, specific details of the exact location of these noise sources are not available. However, an indicative worst case scenario assessment has been undertaken to identify potential noise levels at the closest receptors to indicative substation location (shown in Figure 3.3-3 in Volume 3). The assessment has identified that at the nearest potential location, the maximum reduction in noise levels required by the building/enclosures would need to be 23.3 dB. Typical building/enclosure constructions have been considered and show that a 25 – 30 dB reduction will be readily achievable. The buildings and enclosures will be designed to meet the relevant BS 8233:2014 target external and internal noise levels at all nearby sensitive receptor locations and as such the impact significance will be **'permanent'** but there will be a **'no change'** magnitude of effect on **high sensitivity** receptors, giving an overall **'neutral effect'.** As such, with regard to residual effects, there will be none.

3.3.1.52 The assessment has determined that there will be no operational vibration effects associated with the proposed scheme.

Construction (Modified OnTI)

Noise

3.3.1.53 The most notable effects due to increases in noise during construction would be during periods of earthworks, construction of site infrastructure and the construction of substructures. In addition to onsite sources, increased noise may be caused by HGV movements travelling to and from the site during construction.

3.3.1.54 Whilst construction / demolition noise effects are generally sufficiently controlled by adherence to 'Best Practice' techniques and restricted operating hours, an indicative realistic worst case noise assessment has been undertaken to assess whether any effects that could be significant may arise.

3.3.1.55 The assessment has been undertaken based on the use of assumed construction plant and considering the range of typical activities likely to be employed during the construction phase of the modified OnTI. The following scenarios have been assessed with regard to works occurring at landfall, over the cable route and within the onshore substation area:

- Site preparation: top soil removal
- Site construction of access roads and site compound
- Trench excavation (open trench or cable plough)
- Laying the cable and jointing
- Backfilling the trench
- Re-instatement
- Cable pulling
- Sheet piling.

3.3.1.56 Indicatively, works at the modified offshore export cable landfall point are expected to be undertaken over a 3 month period with specific activities lasting typically up to 1 month. In terms of the modified export cable route, it is expected that a distance of 1.5 km will be progressed per week. The longest period of works will comprise the civil engineering works which are expected to be undertaken over a 24 month period.

3.3.1.57 Information regarding noise emissions from equipment that may be used during the works has been obtained from Annex C of BS 5228-1:2009. This annex presents a range of current sound level data on typical site equipment and common site activities.

3.3.1.58 This data was obtained by field measurements for items of plant in actual use on construction and open sites in the UK. Levels quoted in the database are based on an average (logarithmic) of measured sound levels, and where appropriate have been derived from more than one model of similarly sized plant. The results are presented as un-weighted octave band activity Leq levels, and overall A-weighted activity Leq levels in dB. All sound pressure levels are standardized to 10 m from the plant.

3.3.1.59 With respect to HGV movements, it is anticipated that these will only occur during daytime periods. Therefore, an assessment has been undertaken in accordance with the BS5228 method of mobile plant using a well defined route. Appendix 3.3 A presents predicted noise levels based on data detailed in table 5.6-5 of Chapter 5.6 (Traffic and Transport).

3.3.1.60 In accordance with the ABC method of assessment outlined in BS 5228-1:2009, a significant effect is deemed to occur if the total noise level exceeds the threshold level for the category appropriate to the ambient noise level. It can be seen from the results detailed in the Technical Report (section 3) that no properties are expected to experience a significant effect during the daytime.

3.3.1.61 The OnTI works will be **temporary**, of a **short term** duration and mostly undertaken during standard daytime working hours, Monday to Saturday. However, there is the possibility that due to operational requirements a small amount of construction work will be required outside of these hours and potentially during the night-time period.

3.3.1.62 The assessment detailed in the noise technical report (Appendix 3.3 A) confirms that there could be significant effects of noise at some properties in the event of evening or night-time working.

3.3.1.63 With regard to HGV movements on the public highway, the effects will be transient at locations adjacent to the road network during daytime periods and it has been established that there will be no significant effects from noise or vibration.

Vibration

3.3.1.64 As specified within the MORL TI Scoping Report (MORL, 2014) the vast majority of activities will not generate levels of vibration with would result in significant effects. It is confirmed that there is no cable percussive piling proposed and that only sheet piling will be undertaken during the construction phase.

Decommissioning

Noise

3.3.1.65 The OnTI construction noise assessment is considered to also be representative of any decommissioning works both for removal of the infrastructure and of the substations. As such the conclusions remain the same in that no properties are expected to have a significant effect if the works are undertaken during the daytime, however there could be significant effects of noise at some properties in the event of evening or night-time working.

3.3.1.66 The decommissioning works will be **temporary**, of a **short term** duration and mostly undertaken during standard daytime working hours, Monday to Saturday. However, there is the possibility that due to operational requirements a small amount of decommissioning work will be required outside of these hours and potentially during the night-time period.

3.3.1.67 The assessment detailed in the noise technical report (Appendix 3.3A) confirms that there could be significant effects of noise at some properties in the event of evening or night-time working.

Proposed Monitoring and Mitigation

Operational Noise

3.3.1.68 The design benefits from Gas Insulated Switchgear (GIS) and as such, plant will be housed within buildings fitted with silencers / attenuators. The assessment has identified that at the nearest potential location, the maximum reduction in noise levels required by the building/enclosures would need to be 23.3 dB. Typical building/enclosure constructions have been considered and show that a 25 – 30 dB reduction will be readily achievable. The buildings and enclosures will be designed to meet the relevant BS8233:2014 target external and internal noise levels at all nearby sensitive receptor locations and as such there will be **'no change'** magnitude of effects on **high sensitivity** receptors giving an overall **'neutral effect'**. There will be no residual effects and no requirement for additional mitigation beyond this design.

Construction

3.3.1.69 Construction works may be subject to control by suitably worded planning conditions. It is recommended that 'Best Practicable Means' should be employed to minimise adverse effects.

3.3.1.70 MORL will prepare and adhere to a Construction and Environmental Management Plan (CEMP) within which procedures and methods can be specified to protect noise and vibration sensitive receptors. This will include a series of specific method statements identifying methods of working and controls to address the OnTI development's construction noise and vibration effects. The CEMP will be implemented during the construction phase. Mitigation measures specified below have been included as an example of suitable mitigation measures and should not be regarded as an exhaustive list. Therefore, the following additional mitigation should be considered the minimum additional mitigation required to control and minimise noise impacts from such associated activities:

- Restricting hours of site operation in agreement with Aberdeenshire Council. If there is the requirement to undertake work outside of the agreed hours, further consultation should be undertaken with Aberdeenshire Council.
- For Horizontal Directional Drilling (where required) works the location of noise sensitive receptors should be identified and an assessment of predicted noise levels undertaken to establish the likely effects. Consultation will be undertaken with both the Local Authority and residents where significant effects are predicted.
- Residents located within 100 m of a construction works area during each of the modified OnTI phases should be notified of the works being undertaken. Consultation will also be undertaken at schools and holiday premises within this zone. The times, duration and type of work should be explained. This should be extended as applicable should evening and night-time working be undertaken.
- Careful selection of working methods and programme.
- Selection of quietest working equipment available (e.g. electric/battery powered equipment which is generally quieter than petrol/diesel powered equipment).

- Positioning equipment behind physical barriers, i.e. existing features, hoarding, etc., or provision of lined and sealed acoustic covers for equipment that could potentially contribute to a noise nuisance.
- Positioning of noise generating equipment, such as any blending plant in areas which minimise noise as far is practicable.
- Directing noise emissions away from plant including exhausts or engines away from sensitive locations.
- Ensuring that regularly maintained and appropriately silenced equipment is used.
- Shutting down equipment when not in use, i.e. maintain a 'no idling policy'.
- Handling all materials in a manner which minimises noise.
- Switching all audible warning systems to the minimum setting required by the Health and Safety Executive.
- Where processes could give rise to significant levels of noise, noise levels should be monitored regularly by a suitably qualified person. The methodology of any surveys should be agreed with the Local Authority.
- Employing best practices and follow guidance of British Standard 5228 – Parts 1 and 2.

3.3.1.71 Following the implementation of the above mentioned mitigation works, it is considered that all effects which are significant in EIA terms can be avoided. For daytime works the effect magnitude will be **minor** at receptors of **high sensitivity**. Therefore, the residual effect is **slight / moderate adverse** which, although an important consideration, can be effectively mitigated (as detailed above) to reduce noise levels such that resultant adverse effects are likely to have only a **slight significance**.

3.3.3 Cumulative Impact Assessment

Operational Effects - Substations

3.3.1.72 No committed developments are located within the vicinity (up to 2 km) of the substation area and thus there are no cumulative effects anticipated.

Construction (Modified OnTI)

3.3.1.73 This section presents the results of assessment of the potential cumulative effects upon noise and vibration arising from the modified OnTI in conjunction with other existing or reasonably foreseeable onshore developments and activities. MORL's approach to the assessment of cumulative effects is described in Chapter 1.3 of this ES: Environmental Impact Assessment.

3.3.1.74 It is considered highly unlikely that any construction works associated with other developments, including those undertaken with respect to the three consented wind farms or MORL Western Development Area, will be undertaken at the same location and at the same time as the as the temporary modified OnTI construction works. As such, it is considered highly unlikely that any cumulative noise generation would result in changes to the effects at identified receptors. Similarly, the proposed substations will not generate any cumulative significant noise effects during operation as they would need to be located adjacent to or within the indicative substation locations.

References

Aberdeenshire Council (2012) Aberdeenshire Local Development Plan, adopted 1 June 2012.

Aberdeen City and Shire Strategic Development Planning Authority (SDPA) (2014) Aberdeen City and Shire Strategic Development Plan 2014.

BOWL and Arcus Renewable Energy Consulting Ltd, (2012)Beatrice Offshore Windfarm EIA, October 2012

BS 5228 (2009+A1 2014) – Noise and Vibration Control on Construction and Open Sites, Part 1: Noise

BS 5228 (2009) – Noise and Vibration Control on Construction and Open Sites, Part 2: Vibration

BS 7385 – 2 (1993) – Evaluation and Measurement for Vibration in Buildings, Part 2: Guide to Damage Levels from Groundborne Vibration

British Standard 4142 (1997) - Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas

BS 8233 (2014) – Guidance on sound insulation and noise reduction for buildings

BS 4142:1997 – Method for rating industrial noise affecting mixed residential and industrial areas

Department of Environment, Transport and the Welsh Office (1998) Calculation of Road Traffic Noise.

Department of Transport (November 2011) Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7 – HD 213/11.

EON (2012) Rampion Offshore Wind Farm, ES Section 27 – Noise, December 2012

MORL (2014) MORL TI Scoping Report.

WHO (1999) Guidelines for Community Noise.

3 Physical Environment

3.2 Hydrology, Geology and Contaminated Land

3.2.1 Baseline Information

Introduction

3.2.1.1 This chapter of the ES describes and assesses the effects associated with the hydrology, geology and contaminated land aspects of the MORL modified Onshore Transmission Infrastructure (OnTI). It provides an assessment of the likely effects of the construction, operation and decommissioning of the modified OnTI development on the existing hydrological regime (i.e. flood risk, land drainage and effects on surface water bodies), underlying hydrogeological resources (i.e. groundwater, water supplies and aquifers), geological resources and any existing and arising land contamination within the route corridor.

3.2.1.2 The baseline study consisted of the following aspects:

- Detailed desk study to establish the baseline conditions within the OnTI area;
- Field surveys to inform the baseline assessment;
- Consideration of the relevant key legislative and planning information; and
- Consultation with relevant statutory and non-statutory bodies.

3.2.1.3 Supplementary details of these studies and assessments are detailed in the Technical Appendices.

3.2.1.4 The Study area is defined as a 500 m corridor, 250 m either side of the modified OnTI, extending 34 km from Inverboyndie on the coast, which is approximately 1.9 km to the west of Banff, to the proposed substation location approximately 5.4 km south west of New Deer.

3.2.1.5 Effects on hydrology and the quality and physical integrity of the water environment may result in secondary ecological effects on habitats or species. Effects on ecological receptors are considered in Chapter 4: Biological Environment.

3.2.1.6 A previous assessment of the potential effects of the OnTI was carried out in 2012. This is set out in the MORL Environmental Statement (2012). Since that time the location of the onshore substations has been changed from Peterhead to New Deer and the export cable landfall location has been modified from Fraserburgh to Inverboyndie. The export cable and onshore substations have been modified from Direct Current (DC)/Alternating Current (AC) infrastructure to AC infrastructure only. Accordingly, the impact assessment in this Chapter is a detailed assessment of the new locations and infrastructure now associated with the OnTI.

Consultations

3.2.1.7 A brief summary of the responses from the organisations consulted and the approach that is being adopted by MORL is set out in Table 3.2-1.

Table 3.2-1 Consultations

Organisation	Consultation Response	MORL Approach
Aberdeenshire Council **(Private Water Supplies)**	Records of private water supplies within 500 m of the cable route centreline and the substation were received 27th May 2014.	• Plot sites in project Geographical Information System (GIS); • Site surveys of private water supplies; • Conduct impact assessment; • Identification and incorporation of appropriate mitigation as set out in this report.
Aberdeenshire Council (Contaminated Land)	A GIS shape file with potentially contaminated land sites within the route was provided by the Council.	• Incorporate into project GIS; • Develop conceptual model and identify plausible pathways; • Identification and incorporation of appropriate mitigation as set out in this report.
AHVLA Scotland **(Foot and Mouth Burial Sites)**	AHVLA do not hold any records of Foot and Mouth burial sites in the area, although they stated that this does not mean that these do not exist.	Risk mitigation measures to be highlighted in the construction stage Environmental Management Plan (EMP).
Scottish Environment Protection Agency (SEPA) **(Water Environment)**	Four licensed abstractions are located within 1km of the route centreline. There are no groundwater monitoring sites for level or quality within the search area. SEPA's consultation response also gave advice with regard to disruption to wetland and peatlands, disturbance and re-use of excavated peat, groundwater abstractions, engineering activities in the water environment (meeting the objectives of the Water Framework Directive), water abstraction (CAR, 2011), pollution prevention and environmental management, borrow pits, flood risk (Indicative River and Coastal Flood Map) and regulatory advice.	• Licensed abstractions plotted in project GIS and included in impacts assessment; • Search conducted to identify wetlands/peatlands present; • Mitigation measures outlined in this report take SEPA best practice and regulatory advice into consideration.

Baseline Characteristics

3.2.1.8 Baseline information for the site has been collated through interrogation of the following publicly available information, and previous reports and field based studies, including:

- Previous Environmental Impact Assessment (EIA) Reports – MORL ES Chapters 3.7, 9.3, 13.3 and Technical Appendix 3.7 A (MORL, 2012);
- Scottish Environment Protection Agency (SEPA) – Flood Hazard Maps
- SEPA Water Framework Directive (WFD) classification –Data published for 2008 (cartographic format) and 2012 (report format);
- Ordnance Survey (OS) baseline mapping;
- Photographic evidence collected during site visit;
- British Geological Survey (BGS) UK Hydrogeology Viewer;
- SEPA River Basin Management Plan (RBMP) Interactive Map;
- SEPA Aquifer Productivity;
- BGS online viewer and publicly available downloadable data;

- BGS borehole records;
- Department for Environment, Food and Rural Affairs' (Defra) Magic website;
- Envirocheck Site Sensitivity Data;
- Historical Mapping – National Library of Scotland; and
- Scottish Natural Heritage (SNH) website;
- Macaulay Institute Web site.

3.2.1.9 The modified onshore export cable route corridor passes through a primarily agricultural area the majority of which drains northward to the Moray Firth via a number of rivers and watercourses, some of which are of high environmental value. The River Deveron in particular is an important salmon fishery.

3.2.1.10 The proposed substations are located approximately 5.4 km south west of New Deer. The surrounding area is rural and the dominant existing land use is also agricultural.

3.2.1.11 The drift and solid geology is characterised by superficial alluvial deposits overlying glacial deposits and there are minor aquifers in the area. Both the rivers and aquifers are potentially sensitive to the effects of pollution arising from disturbed areas of contaminated land or from general earthworks operations/spillages. Both the river and the local aquifers are also exploited locally for water supply. Sediment arising from construction works is of particular concern to the sports fishing community as this can negatively affect spawning grounds. These issues have implications for the Water Framework Directive status of water bodies in the study area, as currently defined in the River Basin Management Plan (RBMP).

3.2.1.12 Flood risk is an issue on some of the rivers in this area and the farming community is likely to be concerned about the effect of construction operations on land drainage systems.

3.2.1.13 Relatively few contaminative activities take place within this area, as shown on Figures 3.2.4(a through e). However, there are both historical and current mineral extraction activities along the route and there is a large operational quarry to the west of South Gorrachie.

Desktop Studies

Hydrology

3.2.1.14 A desk study of existing data was undertaken to establish:

- Location, type and distribution of surface water bodies, including peat bogs ;
- Existing flood risk data; and
- WFD and environmental classifications of water bodies along and nearby the modified export cable route.

Location and Distribution of Water Bodies

3.2.1.15 Water bodies potentially affected by the scheme are shown on Figures 3.2-5 (a through e) and listed below:

- Burn of Boyndie
- Burn of Bachlaw (trib. of R Deveron along Paddocklaw)
- River Deveron
- Den Burn (trib. of Burn of Montbletton)
- Burn of Montbletton (trib. of R. Deveron along Wester Keilhill)
- Burn of Fortrie

- Burn of Fishrie
- Craigston Burn
- Small stream next to Hill of Brackans (trib. Of Cot Burn)
- Aultan Burn
- Burn of Monquhitter (Idoch Water)
- Teuchar Stank
- Burn of Swanford
- Burn of Asleid
- Sea at Boyndie Bay

3.2.1.16 The watercourses listed above drain north towards the Moray Firth, apart from the Burn of Asleid and Burn of Swanford, which drain southwards. The River Deveron, with a catchment area at the proposed crossing of 1,232 km^2, is the largest watercourse by a considerable margin.

3.2.1.17 There are no natural lochs or statutorily protected peat bog wetland areas within the area of the modified OnTI apart from a minor open water body at Waggle Hill at the very edge of the onshore export cable route corridor near to the south of the corridor.

3.2.1.18 As productive agricultural land, the area is potentially sensitive to the effects of any activities that affect land drainage systems or which reduce infiltration as a result of soil or subsoil compaction. Details of any under-drainage systems that do exist are unlikely to be available in the form of plans or drawings but local farmers are likely to know of any historic or recently-installed under-drainage measures.

Existing Flood Risk Data

3.2.1.19 A number of the watercourses in the study area have been included in SEPA's National Flood Hazard Mapping work. This provides indicative measures of flood extents; high likelihood (10% annual probability; 1 in 10 years), medium likelihood (0.5% annual probability; 1 in 200 years) and low probability (0.1% annual probability; 1 in 1,000 years). The flood extents associated with the River Deveron are the most significant in the study area . There is a relatively wide floodplain in the vicinity of the modified onshore export cable corridor river crossing south of Bridge of Alvah. Flood extents associated with the remaining watercourses are relatively small. At the coast, the SEPA flood hazard maps show flooding is largely contained at the shoreline at Inverboyndie Bay, with minimal penetration inland. The only significant settlement at risk of tidal flooding is Banff, at the mouth of the River Deveron. However, there is a wide range of infrastructure and numerous minor settlements where flood risk is a potential issue.

3.2.1.20 The landfall point at Inverboyndie has a sandy beach, with the Boyndie Burn cutting through it. There are heavily-vegetated sand dunes at the back of the beach that provide a natural flood defence against tidal flooding. The lower reaches of Boyndie Burn are however affected by tidal effects.

Water Framework Directive Issues and Environmental Classification of Water Bodies

3.2.1.21 SEPA's WFD classifications for 2008 and 2012 were obtained from the RBMPs. The 2008 data can be viewed in cartographic form online, whereas the 2012 classification was consulted via the summary sheets, as no mapping was found. The WFD status/potential of each water body is presented in Table 3.2-2. See Figures 3.2-5 (a through e) for the location of each water body.

Table 3.2-2 SEPA WFD Classification of the Main Water Bodies in the Modified OnTI Corridor

Code (1)	Name	2012 (2)	2008 (3)	Adopted
WB005	Burn of Boyndie	Poor	Poor	Poor
WB008	Burn of Bachlaw (trib. of R Deveron along Paddocklaw)	n/a	n/a	n/a
WB009	River Deveron	Moderate	Moderate	Moderate
WB010	Den Burn (trib. of Burn of Montbletton)	Poor	n/a	Poor
WB011	Burn of Montbletton (trib. of R. Deveron along Wester Keilhill)	n/a	n/a	n/a
WB012	Burn of Fortrie	Bad	Bad	Bad
WB013	Burn of Fishrie	n/a	Moderate	Moderate
WB014	Craigston Burn	n/a	Moderate	Moderate
WB015	Small stream next to Hill of Brackans (trib. Of Cot Burn)	n/a	n/a	n/a
WB016	Aultan Burn	n/a	n/a	n/a
WB017	Burn of Monquhitter (Idoch Water)	Bad	Bad	Bad
WB018	Teuchar Stank	n/a	n/a	n/a
WB019	Burn of Swanford	n/a	n/a	n/a
WB020	Burn of Asleid	n/a	n/a	n/a
WB021	Sea at Boyndie Bay	Good	Good	Good

(1) Code used for this study

(2) http://www.sepa.org.uk/water/river_basin_planning/waterbody_data_sheets.aspx, see also

(3) http://gis.sepa.org.uk/rbmp

3.2.1.22 The issues affecting water body status include a range of factors such as physical modifications and biological/water quality issues associated primarily with agricultural activity. The River Deveron is a game fishery with a sustainable population of salmon, sea trout and brown trout. It has been identified by SEPA as a Diffuse Pollution Priority Catchment. Effects on salmon and trout are discussed in more detail in Chapter 4.2: Fish and Shellfish Ecology.

3.2.1.23 Arable cultivation, livestock farming and forestry are the main land use activities in areas affected by diffuse pollution on the River Deveron. It is a drinking water protected area (DWPA), providing drinking water for 60,000 people in the Aberdeenshire area. The river has also been designated as a Salmonid Water under the EC Water Framework Directive. Areas of the catchment are included in a Nitrate Vulnerable Zone and the entire catchment has been designated as an Urban Waste Water Treatment Directive Sensitive Area.

3.2.1.24 The modified OnTI area does not intersect any wetland RAMSAR, SAC or SSSI sites.The response by Aberdeenshire Council to the Scoping Report highlights the importance of the SSSI zones between Cullen and Stake Ness and Whitehills to Melrose, but these will not be impacted by the development which landfalls on the beach.

3.2.1.25 Whilst there are no peat bog wetlands, there are four areas within the modified OnTI area where the soils comprise peat (see Figure 3.2-3 (a through e)). Two of these are restricted to a narrow corridor along Teuchar Stank. There is an approximately 100 m² square area at Boghead Farm, south of Cuminestown (NGR 38000, 848821). The largest area of peat is the Moss of Sprottyneuk (NGR 381689, 846124), which comprises a shallow depression occupying approximately 1 km², as noted in the geology sections of this report. This area has been artificially drained in the past and appears to be currently used as rough grazing land.

Solid Geology

3.2.1.26 The 1:625,000 BGS mapping shows that the solid geology beneath the modified OnTI area comprises:

- The Southern Highland Group (SOHI);
- The Middle Old Red Sandstone (MOR);
- Lower Old Red Sandstone (LOR); and
- Igneous Intrusion.

3.2.1.27 SOHI comprises metamorphic rock and is found beneath the southern and northern-most ends of the modified OnTI area.

3.2.1.28 The Middle and Lower Old Red Sandstone are located in the central section of the modified OnTI area and comprise conglomerates, breccias, mudstones, sandstone and siltstones.

3.2.1.29 An igneous intrusion of quartz- microgabbro occurs directly beneath the indicative substations location. The intrusion lies in almost an east – west alignment and will be considered during foundation designs for the substations.

3.2.1.30 A large geological fault crosses the proposed cable alignment at three locations between Gorrachie Wood (NGR 374641, 856078) and to the south of Fintry (NGR 375597, 854257), and lies generally in a north –south alignment.

Superficial Geology

3.2.1.31 The superficial geology is complex and includes till, raised marine deposits, river terrace deposits, alluvium, glacio-fluvial deposits and some localised areas of blown sand and peat.

3.2.1.32 The majority of the superficial deposits along the route comprise Till, Devensian – Diamicton (TILLD). This has a variable composition, but generally comprises sandy, silty clay with pebbles.

3.2.1.33 Alluvium deposits outcrop along the route, following and adjacent to the surface watercourses. This is described by the BGS as clay, silt and sand. Alluvial deposits are mapped in two small isolated patches on the banks of the River Deveron at Inverichnie [NGR 369314,860645 and 369753, 860120] and here are described as gravel, sand, silt and clay. River Terrace Deposits (undifferentiated) occur in small isolated patches along the major surface water channels and are described as sand and gravel, with local lenses of silt, clay or peat.

3.2.1.34 Glaciofluvial Ice Contact deposits (GFIC) are extensively mapped in the northern section of the modified OnTI area and are described as sand and gravel, with localised lenses of silt, clay and organic material. Glaciofluvial Sheet Deposits (GFSD) are mapped along the River Deveron.

3.2.1.35 Head deposits occur at three locations along the route. The largest outcrop is located to the north of the Hill of Alvah (approximate NGR 366867, 860235). Head is described as comprising gravel, sand and clay depending on upslope source (this being the SOHI) and distance from source. Poorly sorted and poorly stratified deposits formed mostly by solifluction and/or hillwash and soil creep.

3.2.1.36 Peat occurs in isolated patches towards the southern end of the route, the largest area of peat is situated at Moss of Sprottyneuk . Blown Sand is confined to a small outcrop near the remains of the church at Boyndie Bay and is described as pale brown, fine-grained, uncemented sand.

3.2.1.37 Raised Marine Deposits at Inverboyndie comprise a variable lithology of gravel (shingle), sand, silt and clay, and are commonly enriched with organic debris.

3.2.1.38 There is no made ground shown on the geological mapping.

Geological Designations

3.2.1.39 The Whitehills to Melrose Coast was designated as a geological Site of Special Scientific Interest (SSSI) in 1990 for the structural and metamorphic geology. The SSSI covers an area of 90.30 hectares extending from Whitehills, approximately 1.5 km to the west of Inverboyndie Bay, to Bowie Bate approximately 4.5 km to the east of the bay. Inverboyndie Bay itself does not fall within the SSSI designation. The designation applies to the exposed bedrock geology either side of the bay and the cable will not come ashore onto these areas.

BGS Borehole Records

3.2.1.40 There are no publicly available BGS borehole records that fall within the 1,000 m buffer of the modified OnTI area.

Aquifer Classification

3.2.1.41 The BGS online Hydrogeology Viewer for the UK provides a description and classification of the bedrock in terms of aquifer potential, whereas MacDonald et al. (2004) gives an indication of yields associated with this classification. A summary of these bedrock aquifers is presented below.

3.2.1.42 Southern Highland Group (MacDuff Formation and Knockhead Grit Member): Classified as a Low Productivity Aquifer with a yield of 0.1 to 1 l/s. This aquifer is capable of providing only small amounts of groundwater in the near surface weathered zone and secondary fractures. It is likely that these aquifers are only used for small domestic supplies.

3.2.1.43 Middle Old Red Sandstone (Gardenstown Conglomerate Formation): Classified as a Moderately Productive Aquifer with a yield of between 1 and 10 l/s. The aquifer is described as sandstones, in places flaggy, with siltstones, mudstones and conglomerates and interbedded lavas, locally yields small amounts of groundwater, which obtains its yield from both intergranular and fracture flow.

3.2.1.44 Lower Old Red Sandstone (Crovie Sandstone Formation): Classified as a Moderately Productive Aquifer with a yield of 1 to 10 l/s. The aquifer is described as a locally important multi-layered aquifer which obtains its yield from both intergranular and fracture flow.

3.2.1.45 The BGS UK Hydrogeology Viewer does not include superficial deposits. However, MacDonald et al. (2004) do present a map of superficial aquifer productivity, which also contains a classification table for superficial deposits. Based on this, the classification of the superficial deposits are as presented in Table 3.2-3 below.

Table 3.2-3 Superficial Deposit Classifications

Productivity Rating	Superficial Deposits
High (>10 l/s)	Glaciofluvial Sands and Gravels Alluvium River Terrace Deposits
Moderate (1-10 l/s)	Raised Marine Deposits
Low (0.1-1 l/s)	Sandy and gravelly Glacial Till

Groundwater Vulnerability

3.2.1.46 Groundwater vulnerability data has been obtained from Envirocheck and from the BGS/SEPA classification for Scotland.

3.2.1.47 The Envirocheck classification correlates to the superficial deposits. The Glacial Sand and Gravel, Alluvium and Raised Marine Deposits are classified as Minor or Moderately Permeable Aquifer, whereas the Glacial Till is classified as Non- or Weakly Permeable Aquifer.

3.2.1.48 The BGS/SEPA (O'Dochartaigh et al., 2011) groundwater vulnerability classification has been used in the impact assessment to derive the value/sensitivity of groundwater as a receptor. This indicates that the bedrock, in combination with the overlying superficial deposits along the onshore export cable route corridor and substation site are designated predominately as vulnerability class 4a-5 with some isolated areas classified as vulnerability class 2 or 3. The vulnerability classes are defined in Table 3.2-4 below.

Table 3.2-4 Groundwater Vulnerability Classifications and Their Interpretation (O'Dochartaigh *et al.*, 2011)

Vulnerability Class	Description		Frequency of activity	Travel time
5	Vulnerable to most pollutants, with rapid impact in many scenarios.		Vulnerable to individual events.	Rapid
4	Vulnerable to those pollutants not readily adsorbed or transformed.	4a May have low permeability soil; less likely to have clay present in superficial deposits.	↓	↓
		4b More likely to have clay present in superficial deposits.		
3	Vulnerable to some pollutants; many others significantly attenuated.			
2	Vulnerable to some pollutants, but only when they are continuously discharged/leached.			
1	Only vulnerable to conservative pollutants in the long term when continuously and widely discharged/leached.		Vulnerable only to persistent activity.	Very slow
0	Not sufficient data to classify vulnerability: e.g. below lochs; in urban areas where geological and/or soils data are missing; where superficial deposits are mapped but not classified; or in mined (including opencast) and quarried areas.			

3.2.1.49 For the purposes of this assessment groundwater has been conservatively classified as a single receptor of vulnerability class 4a-5, rather than as individual receptors corresponding to the aquifers.

Groundwater Levels and Flow

3.2.1.50 A data request for groundwater level data has been submitted to SEPA as part of the consultation process detailed . The response from SEPA indicated that there is no monitoring data within 1km of the centreline of the cable route.

3.2.1.51 There are no BGS water wells or borehole records available on the online database within the modified OnTI area, but some data may be available in archive and will be requested for use in the design of the site investigation.

3.2.1.52 It is considered likely that the groundwater flow directions within the bedrock aquifers will follow the direction of the dip of the geology, unless modified locally by pumping. Groundwater within the superficial deposits will most likely correlate to topography with flow towards stream/ river channels.

Groundwater Quality

3.2.1.53 A data request for groundwater water quality data was submitted to SEPA as part of the consultation process. The response from SEPA indicated that there is no monitoring data within 1km of the centreline of the cable route. SEPA classify key water bodies as part of their River Basin Management Plans (RBMPs), which form part of the legislator requirements under the WFD. Along the cable route there are several groundwater bodies defined. These groundwater bodies, together with their water quality status in 2008, are presented in Table 3.2-5 below.

Table 3.2-5 Groundwater Bodies and Water Quality Status

ID	Groundwater Body	Location along route	Water Quality Status (2008)	Drinking Water Protection Zone?
150316	Banff coastal sand and gravel	Raised Marine Deposits along coastline adjacent to Banff	Good	Yes
150311	Buchie bedrock and localised sand and gravel aquifer	Knockhead Grit Member at Inverboyndie	Good	Yes
150312	Lower Devron Valley Sand and Gravel	Glaciofluvial Ice Contact Deposits immediately to the south of Banff and Inverboyndie	Good	Yes
150404	MacDuff	Corresponds to MacDuff Formation between Banff and Fintry	Good	Yes
150307	Turriff bedrock and localised sand and gravel aquifers	Corresponds to the Old Red Sandstone between Fintry and Cuminestown	Poor (diffuse pollution from nitrate use in arable farming)	Yes
150300	Ythan bedrock and localised sand and gravel aquifers	MacDuff formation south of Cuminestown to end of the route	Poor (diffuse pollution from nitrate use in arable farming)	Yes

3.2.1.54 The RBMP database also presents Drinking Water Protection Zones, as designated under the Drinking Water Directive. All the water bodies listed above are classified as Drinking Water Protection Zones.

Historical Mapping

3.2.1.55 Historical mapping for the modified OnTI area was reviewed via publicly available online resources from the National Library of Scotland. A summary of the key findings is given below.

- Historically, the area was and remains predominantly agricultural;
- There are a number of small local quarries shown on the historical mapping along the route, most of which are referred to as old gravel pits;
- The current distillery in Inverboyndie was first shown on the OS mapping dated 1904.
- The Banff Branch and Macduff Branch railways crossed the route in 1904 although are now both shown as disused/ dismantled.
- There is evidence of local smithies being present along the route in the past with a number of wind pumps and mills.

Envirocheck Sensitivity Data

3.2.1.56 An Envirocheck Report was commissioned for the modified OnTI area with a 500 m buffer either side, although the study area was subsequently reduced to 250 m either side (see Figure 3.2-1). The Envirocheck Report comprised site sensitivity data. A summary of the key findings is given below:

- There are four contemporary trade directory entries within the route corridor, of which three are active;
- There are no Control of Major Accident Hazards (COMAH) registered sites;
- There is one recorded petrol station, now obsolete (at Keilhill);
- There are eight BGS recorded mineral sites, all are completed opencast mines;
- There are five records for non-coal mining areas, located in the central section of the route. Identified as vein minerals classed as “Rare: Infrequent minor mining may have occurred but restricted in extent”;
- There are two registered waste transfer sites for one site at Inverboyndie;
- There is one registered landfill at Foulzie. The license status is given as lapsed/ surrendered, i.e. is no longer operational; and
- The site falls within a Nitrate Vulnerable Zone.

Potentially Contaminated Land – Aberdeenshire Council

3.2.1.57 The Environmental Health Officer (EHO) at Aberdeenshire Council identified a number of potentially contaminated sites in the scoping response. The Council has provided a list of the contaminated sites of which 34 fall within the modified OnTI area (see Figure 3.2-4 (a through e)). These comprise:

- Eleven Quarries or gravel pits;
- One Smithy;
- Keilhill filling station (as listed in Envirocheck, now obsolete);
- Two sawmills and 14 unspecified mills;
- One fabricators (steel, aluminium and stainless steel welders);
- One store (Parkhill stores);
- One agricultural engineers;
- One commercial business (unspecified); and
- One unspecified activity (given as Inverboyndie).

3.2.1.58 Based on the information provided by the Council the sites have been screened using the Aberdeenshire Council Contaminated Land Strategy Land Use Risk Rating. All but two of the sites fall into the low risk category. The former petrol filling station and the fabricators are rated as medium risk sites.

Site Specific Surveys

3.2.1.59 Site visits took place between 2nd and 6th June 2014. The full length of the modified OnTI area was inspected including the location of the the substations. As the modified export cable route is 33 km long, the full route was driven, where possible, with walkover surveys at key locations.

3.2.1.60 Photographs were taken of relevant locations, such as proposed river crossings, structures, potential contaminated land sites, private water supply locations and geomorphological features as well as of the general landscape. The locations were determined from the desk based review. The information collected was used to improve understanding of the sensitivity of the water bodies and receptors, respectively.

Survey of Surface Water Features

3.2.1.61 The landfall point and all surface watercourse crossings were surveyed. With the exception of the River Deveron, the majority of the watercourses – especially the smaller ones - have been modified, straightened or deepened to increase their capacity. Since the land is mainly dedicated to crop production and grazing, the channels are commonly straightened and productive agricultural land extends to the bank tops of the majority of watercourses. Low raised embankments commonly bound the channels. The channels are generally incised, with evidence of bank toe undercutting, and have very steep banks, which were covered in dense vegetation (high grass and bushes) at the time of the site visits (June 2014). The watercourse bed material is generally gravel, often covered by fine soil/sediment particles. These deposits are most common in the smaller watercourses and drains. These fines are also found attached to macrophites (e.g. algae) on the bed.

Survey of Water Supplies

3.2.1.62 Properties registered with Aberdeenshire Council as having a private water supply were visited within the modified OnTI area. Only water supplies falling within 500 m of the export cable corridor centreline or the area of the substations were visited. From the Council records, this included 58 private water supplies serving a total of 77 properties. The location and type of supply (well, surface water or spring) was recorded. From the site surveys of private water supplies, 21 properties were found to have switched to a mains supply and seven properties were derelict or empty.

3.2.1.63 Licensed abstraction data from SEPA identified 4 licensed/registered abstractions within 1 km of the cable route centreline. Aberdeenshire Council identified one abstraction, Fortrie Intake, within 500 m of the cable route centreline. The area where this intake is located was visited as part of the site survey. In addition Brackans Reservoir, a Scottish Water service reservoir, was briefly inspected. The source of water feeding this reservoir will be confirmed with Scottish Water, but it forms part of the distribution network and therefore has no natural catchment draining to it. The location of the private water supplies, licensed/ registered abstractions, Fortrie Intake and Brackans Reservoir, are presented on Figure 3.2-5 (a through e).

Legislative and Planning Framework

3.2.1.64 The specific supplementary legislation that was taken into account in the hydrology, geology and contaminated land baseline and assessment is outlined below:

- Water Framework Directive (WFD) 2000/60/EC (European Council, 2000). A framework for Community action in the field of water policy;
- Groundwater Daughter Directive to WFD 2006/118/EC (European Council, 2006). Daughter directive to WFD in order to prevent and control groundwater pollution;
- Freshwater Fish Directive 2006/44/EC (European Council, 2006). Directive on the quality of waters needing protection or improvement in order to support fish life;
- Water Environment and Water Services (Scotland) Act (Scottish Parliament, 2003). Act of the Scottish Parliament to make provision for the protection of the water environment;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011(Scottish Ministers, 2011) and Amendment Regulations 2013. Regulations covering controlled activities which may affect the water environment;

- Environmental Protection Act 1990: Part IIA Contaminated Land (Parliament of the United Kingdom, 2000). Section of the Environmental Protection Act in relation to the use and remediation of contaminated Land;
- Contaminated Land (Scotland) Regulations 2000 (Scottish Minister, 2000) and Amendment Regulations 2005. Places duty on Local Authorities to identify and secure the remediation of contaminated land in their respective areas;
- Scottish Planning Policy (Scottish Government, 2010). A statement of Scottish Government Policy on land use planning, including subject policies on Flooding and Drainage. A revised version of the Scottish Planning Policy that was released on 23 June 2014 was also considered.;
- Flood Risk Management (Scotland) Act 2009 (Scottish Ministers, 2009). An Act to make provision about the assessment and sustainable management of flood risks;
- EU Groundwater Directive 80/68/EEC (European Council, 1979). This directive was largely replaced by the WFD in 2000;
- EU Drinking Water Directive 98/83/EC (European Council, 2003). Directive on the quality of water intended for human consumption;
- Groundwater Protection Policy for Scotland, Version 3 – Environmental Policy 19 (SEPA, 2009); and
- Private Water Supply (Scotland) Regulations 2006 (Scottish Ministers, 2006). Transpose the revised European Drinking Water Directive (Council Directive 98/83/EC), and update earlier Regulations. Their overriding objective is to ensure the provision of clean and wholesome drinking water and deliver significant health benefits to those using such supplies.

3.2.1.65 The relevant guidance that was considered when compiling the hydrology, geology and hydrogeology assessment is as follows:

- Aberdeenshire Local Development Plan (Aberdeenshire Council, 2012), including Policy 4 on Special Types of Rural Land, Policy 14 on Safeguarding of resources and Supplementary Guidance documents on development in the coastal zone, protection and conservation of the water environment, flooding and erosion and contaminated land;
- Development in the Coastal Zone, Policy 14 on Safeguarding of Resources and SPG Protection and conservation of the water environment;
- Aberdeenshire Council, Planning and Environmental Services (Revised 2011). Contaminated land strategy;
- Code of Practice for Earth Works (BS6031:1981)(British Standards Institute, 1981);
- Environmental Protection Act 1990: Part IIA Contaminated Land Statutory Guidance: Edition 2, Paper SE/2006/44 (Scottish Executive, 2006). Guidance on the interpretation and implementation of Part IIA;
- Planning Advice Note 33: Development of Contaminated Land (Scottish Executive, 2000). Guidance on the Development of Contaminated Land;
- Planning Advice Note (PAN) 61: Planning and Sustainable Urban Drainage Systems (Scottish Executive, 2001). Guidance on Sustainable urban Drainage Systems;
- Planning Advice Note 79: Water and Drainage (Scottish Executive, 2006). Guidance on the Planning and Delivery of new Water and Drainage infrastructure;
- PPG1: General guide to the prevention of pollution (SEPA, 2013);

- PPG2: Above ground oil storage tanks (SEPA, 2010);
- PPG5: Works and maintenance in or near water (SEPA, 2007);
- PPG6: Working at construction and demolition sites (SEPA, 2012);
- PPG8: Safe Storage and Disposal of Used Oils (SEPA, 2004);
- PPG18: Managing fire water and major spillages (SEPA, undated);
- PPG21: Pollution incident response planning (SEPA, 2009);
- PPG26: Safe storage - drums and intermediate bulk containers (SEPA, 2011);
- SEPA Controlled Activities Regulations: A Practical Guide (SEPA, March 2014);
- SEPA Good Practice Guide - Bank Protection (WAT-SG-23) April 2008;
- SEPA Good Practice Guide - River Crossings (WAT-SG-25) (SEPA, Nov 2010);
- SEPA Good Practice Guide - Sediment management (WAT-SG-26) (SEPA, June 2010);
- SEPA Good Practice Guide – Construction Methods (WAT-SG-29) (SEPA, March 2009);
- SEPA Good Practice Guide – Riparian Vegetation Management (WAT-SG-44) (SEPA, March 2009);
- SEPA Silt Control Guidance (SEPA, July 2013);
- An Introduction to Land Contamination and Development Management (SEPA and various Scottish Councils, 2010);
- SEPA (2006). Prevention of Pollution from Civil Engineering Contracts: Guidelines for the Special Requirements;
- Forestry Commission (2003). Forest and Water Guidelines. 4th edition;
- Scottish Executive (2000). River Crossings and Migratory Fish: Design Guidance. A Consultation Paper;
- Murnane, E., Heap, A. & Swain, A. 2006). Control of Water Pollution from Linear Construction Projects, Technical Guidance (C648). CIRIA;
- Murnane E. et al. (2002) Control of Water Pollution from Construction Sites – Guide to Good Practice (SP 156). CIRIA; and
- Connolly, S. & Charles, P. (2005) Environmental Good Practice on Site (C650). CIRIA.

3.2.2 *Impact Assessment*

Summary or Effects and Mitigation

3.2.2.1 This chapter considers the likely significant effects of the modified OnTI on the hydrology, geology and contaminated land. Further details on how individual effects have been assessed can be found in section 3.2.2.5.

Summary of Effects

3.2.2.2 The effects considered were as follows (see Table 3.2-6):

- Changes to surface runoff patterns and land drainage systems;
- Physical deterioration in water bodies (WFD);
- Water quality deterioration in water bodies (WFD);

- Increased flood risk due to loss of floodplain storage or conveyance capacity;
- Increased flood risk due to placing new receptors in flood zones or due to compromising existing flood and coastal erosion management measures;
- Soil/Subsoil compaction and reduced infiltration to groundwater;
- Release of sediment to the water environment (water supplies);
- Alteration of groundwater levels;
- Alteration of groundwater flow paths;
- Accidental release of contaminants;
- Disturbance and movement of contaminated materials.
- Human Health impacts from contaminated land;
- Damage to geological sites; and
- Sterilisation of mineral reserves.

Proposed Mitigation Measures and Residual Effects (Bold)

3.2.2.2 The primary mitigation technique is to route the cables and site the substations away from contaminated land and sensitive receptors. The corridor is sufficiently wide to provide some flexibility in this regard. Site investigations and consultation will be undertaken to inform the design process. Use of the guidance listed in Section 3.2.1.65 will be required to develop a construction stage Environmental Management Plan (EMP), together with emergency procedures for managing environmental incidents on site. All works affecting the water environment are likely to require a Controlled Activities Regulations (CAR) license from SEPA. Specific measures that will be used to ensure that the significance of the residual effects associated with hydrology, geology and contaminated land, are either of minor or negligible significance, include the following:

- Detailed consultation with the relevant stakeholders and key parties identified as potentially affected;
- Detailed site investigations to inform a design that avoids all unnecessary negative effects;
- Measures to prevent soil compaction and ensure that affected land drainage systems are reinstated;
- Use of best practice sustainable drainage and sediment management techniques;
- Where appropriate, use of horizontal directional drilling (HDD) beneath sensitive water bodies;
- Measures to ensure that no increases in local flood risk occur;
- Pollution risk reduction measures.

3.2.2.3 These measures are described in detail in Section 3.2.2.42 to 3.2.2.66.

3.2.2.4 A maintenance plan will be required for the operational phase, which ensures that the water environment will not be affected by maintenance and repair operations.

3.2.2.5 There are negligible residual effects upon the majority of all hydrology, geology and contaminated land receptors, as outlined in Table 3.2-6 below. The accidental spillage of pollutants during construction, and potential effects on water supplies, is assessed as being of minor significance following mitigation, as is the effects from contaminated land and ground gas. The disturbance and mobilisation of contaminated material relating to aquifers and water supplies also has a residual effect of minor significance.

Table 3.2-6 Impact Assessment Summary

Effect	Receptor	Pre-mitigation effect	Mitigation	Post-Mitigation Effect
Construction and Decommissioning				
Temporary changes to surface runoff patterns and land drainage systems. **Permanent effects of substation and associated drainage infrastructure.**	Land and field drainage systems	Minor Significance (High Sensitvity water bodies) Negligible (Low sensitivity water bodies)	Construction stage Environmental Management Plan (EMP) to specify site best practices. All ground surfaces to be reinstated to pre-existing levels. Any affected field under-drainage systems fully reinstated. Substation drainage to be attenuated to greenfield rates and separated from any existing field drainage systems.	Negligible
Temporary physical deterioration in water bodies	Water bodies	Major significance (High Sensitvity water bodies) Minor significance (Low sensitivity Water Bodies)	Use below-ground horizontal directional drilling (HDD) techniques to avoid affecting high sensitivity water bodies. Adopt site best practices to minimise temporary impacts. Fully reinstate water bodies to pre-existing condition following construction.	Negligible
Temporary water quality deterioration in water bodies	Water bodies	Major significance (High sensitivity water bodies) Minor significance (Low sensitivity water bodies)	Adoption of site best practices to minimise pollution risk from construction plant and materials.	Negligible
Temporary soil erosion of working area and release of sediment into water environment	Water bodies	Major significance (Sensitive water bodies) Minor significance (Low sensitivity water bodies)	Adoption of site best practices. Construction on steep slopes will, where possible, be avoided. Best practice site sustainable drainage/sediment control practices will be adopted to ensure that this issue is tackled at source and there are no direct routes by which sediment-laden runoff can enter local water bodies.	Negligible

Effect	Receptor	Pre-mitigation effect	Mitigation	Post-Mitigation Effect
Temporary increased flood risk due to loss of floodplain storage or channel conveyance capacity	Water bodies	Major significance (High sensitivity water bodies) Minor significance (Low sensitivity water bodies)	No filling of floodplain areas. Temporary crossings of low sensitivity water bodies, where HDD techniques are not used, will be designed to ensure no increase in flood risk to local receptors. On completion, the physical alteration of the channel geometry will be reinstated to its pre-existing condition, with temporary erosion protection measures employed where necessary to ensure bank vegetation becomes fully re-established.	Negligible
Permanent increased flood risk by introducing new receptors into flood risk areas or due to existing flood and coastal erosion management measures being damaged or otherwise compromised.	Water bodies	Major significance (High sensitivity water bodies) Minor significance (Low sensitivity water bodies)	Location of the substation and other permanent assets and construction works in areas of low flood risk. Design and construction of new infrastructure to ensure that the integrity of existing flood defence assets is preserved.	Negligible
Changes to surface runoff and drainage	Water supplies/ abstractions	Minor significance (High and Very High sensitivity water supplies) Negligible (Low sensitivity water supplies)	Adoption of site best practices. Confirm source of supply from receptors and ensure water supply to these is not affected by development. Construction stage EMP to detail temporary diversions, downstream recharge etc.	Negligible
Release of sediment to the water environment (temporary)	Aquifers and water supplies	Minor significance (Medium- Very High sensitivity receptors) Negligible (Low sensitivity water supplies)	Adoption of site best practices as above.	Negligible
Subsoil compaction and reduced infiltration	Aquifers and water supplies	Minor significance (Medium- Very High sensitivity receptors) Negligible (Low sensitivity water supplies)	Limit area of compaction using same access route - detail in EMP.	Negligible
Alteration of groundwater levels, disruption to flow paths	Aquifers/ water supplies	Minor significance (Medium- Very High sensitivity receptors) Negligible (Low sensitivity water supplies)	No large scale abstraction proposed. Use sump pumps where necessary. Undertake ground investigation to determine the depth to groundwater. before undertaking detailed design.	Negligible

Effect	Receptor	Pre-mitigation effect	Mitigation	Post-Mitigation Effect
Accidental spillage of pollutants (eg fuel oils and lubricants)	Aquifers/ water supplies	Significant (Medium- Very High sensitivity receptors) Minor Significance (Low sensitivity water supplies)	EMP to include site best practices including PPG 21 Pollution Incidents Response Planning, including responding in a timely manner and planning for alternative water supply in event of pollution of a local water supply.	Minor significance (Medium- Very High sensitivity receptors) Negligible (Low sensitivity water supplies)
Effects from contaminated land and ground gas (e.g. inhalation, dermal inhalation, dermal contact, ingestion, direct ingestion, direct exposure) **Generation of contaminated waste.**	Human health	Major significance	Cable route alignment to avoid areas of contamination. Ground investigation at key locations to allow risks to be assessed and mitigated in detail. EMP to detail residual risk management measures; use of Personal Protective Equipment as last line of defence.	Minor significance
Damage to nearby geologically important sites	White hills to Melrose Coast SSSI Cullen to Whitehills Coast and Tarlair to Gardenstown Coast Local Nature conservation sites.	Significant	Consultation with key stakeholders; detailed and careful route alignment aided by a coastal geomorphological assessment; design construction and decommissioning techniques to avoid impacts. EMP to detail site Best Practice techniques and relevant PPGs.	Negligible
Sterilisation of mineral reserves	Mineral reserves	Minor significance	Consultation with key stakeholders and relevant parties.	Negligible
Disturbance and mobilisation of contaminated material	Surface water features	Minor significance	Ground investigation in areas identified as potential sources of significant contamination; EMP with contingency for encountering unexpected contamination such as Foot and Mouth burial sites; Method statement for drilling operations; and following best practice techniques and relevant PPGs.	Negligible
	Aquifers/ water supplies	Major Significance (Very High sensitivity receptors) Minor Significance (Low sensitivity receptors)		Minor significance (Medium- Very High sensitivity receptors) Negligible (Low sensitivity water supplies)
	Coastal environment	Minor significance		Negligible

Effect	Receptor	Pre-mitigation effect	Mitigation	Post-Mitigation Effect
Operation				
Changes to surface runoff patterns and land drainage systems.	Water bodies	Minor significance	Develop maintenance plan which uses designated routes and procedures designed to ensure maintenance operations do not affect local drainage systems.	Negligible
	Water supplies / abstractions	Minor significance (high and very high sensitivity water supplies) Insignificant (low sensitivity water supplies	Confirm source of supply from receptors and ensure water supply to these is not affected by development. Detailed design to minimise alterations to surface runoff and drainage. In line with PPG5 Work and maintenance in or near water.	Negligible
Soil compaction and reduced infiltration resulting in increases in localised overland flooding	Water bodies	Minor significance	Develop maintenance plan which uses designated routes and procedures designed to ensure maintenance operations do not result in compaction of agricultural soils.	Negligible
Physical deterioration in water bodies	Water bodies	Minor significance	Develop maintenance plan which uses designated routes and procedures designed to ensure maintenance operations do not result in physical deterioration of water bodies.	Negligible
Water quality deterioration in water bodies	Water bodies	Minor significance	Develop maintenance plan which uses designated routes and procedures designed to ensure maintenance operations do not result indeterioration in water quality within water bodies.	Negligible
Soil erosion and release of sediment into water environment	Water bodies	Minor significance	Develop maintenance plan which uses designated routes and procedures designed to mitigate the risk of maintenance operations resulting in sediment releases.	Negligible
Increased flood risk due to loss of floodplain storage or channel conveyance capacity	Water bodies	Minor significance	Develop maintenance plan which uses designated routes and procedures designed to mitigate the risk of maintenance operations affecting floodplain storage or conveyance.	Negligible

Effect	Receptor	Pre-mitigation effect	Mitigation	Post-Mitigation Effect
Increased flood risk by introducing new receptors into flood risk areas or due to existing flood and coastal erosion management measures being damaged or otherwise compromised	Water bodies	Minor significance	Where these cannot be avoided, develop maintenance plan which uses designated routes and procedures designed to mitigate the risk of maintenance operations affecting existing flood defences, including natural ones (e.g. sand dunes)	Negligible
Alteration of groundwater levels, disruption to flow paths	Aquifers/ water supplies	Minor significance (High - Very High sensitivity receptors) Insignificant (Medium - Low sensitivity water supplies)	No large scale abstraction proposed. Use sump pumps where necessary. Undertake ground investigation to determine the depth to groundwater and flow regime before undertaking detailed design.	Negligible
Accidental release of contaminants during substation operation	Aquifer (Class 4a)/Water supply well	Major Significance (Aquifer Class 4a) Significant (water supplies)	Regular inspections of site during operation to detect any release of contaminants. Confirm source of supply for PWS/N/0653. Detailed design to include the use of bunds around chemical/ fuel storage areas etc. (PPG8 Safe Storage and Disposal of used oils; PPG26 Safe storage - drums and intermediate bulk containers).	Minor Significance (Aquifer Class 4a) Minor Significance (water supplies)
Contaminated land and ground gas at Substations and along cable route	Human Health	Major significance	Environmental Monitoring and Management Plan, to include for example requirements for long term gas monitoring, PPE, health and safety issues and maintenance procedures and identifying sensitive land use areas or designations	Minor significance

Introduction to Impact Assessment

3.2.2.6 The assessment methodology is based on A Handbook on Environmental Impact Assessment (4th edition, 2013) by Scottish Natural Heritage (SNH). The significance of the likely effects of the modified OnTI has been defined by taking into account the sensitivity of the receptors and the potential magnitude and probability of the effect.

Details of Impact Assessment

3.2.2.7 Baseline desk studies were undertaken of the areas potentially affected by the proposals, as outlined in Figure 3.2-1 (Site Plan). These assessments included a review of relevant baseline information such as water quality data, historic land use, location of watercourses, site topography, designated areas, private water supplies, superficial and solid geology maps, groundwater maps, etc.

3.2.2.8 Initial findings were then verified using site surveys. The information collected during these surveys complemented the data collected and analysed during the desk study stage in order to:

a) Identify receptors and define their sensitivity;

b) Group the receptors according to their sensitivity;

c) Elaborate a list of potential effects and their significance; and

d) Correlate effects with receptors (pathways) and obtain the significance of the effect.

3.2.2.9 The above sequence also provided a series of mitigation measures to eliminate or reduce the impact of the effects.

3.2.2.10 The surface water receptors (water bodies) identified in the study area comprise the Moray Firth, rivers and minor watercourses (see Figure 3.2-5 (a through e)). No notable lochs or reservoirs were noted within the modified OnTI area, other than the service reservoir at Brackans. Whilst a few isolated areas of peat are present, most notably the Moss of Sprottynook, these have been artificially drained and are no longer associated with open water wetland features (Figure 3.2-3 (a through e)).

3.2.2.11 The definition of the sensitivity of surface water bodies was based on factors such as WFD classification, size of the channel, flood risk, environmental designation and water body use. The magnitude of the potential effect was judged in terms of the severity, size and duration of the effect. The parameters for defining sensitivity and magnitude are set out in detail Table 3.2-8.

3.2.2.12 Conceptual site models for key risk sites within the modified OnTI area have been developed, identifying existing or future potential source-pathway-receptor linkages and the plausibility of these in the context of each site setting (these are detailed in the technical appendix). Where appropriate, recommendations for intrusive site investigations prior to construction have been made. Consideration has been given to land that potentially contains contamination and/ or land that has special geological significance, either from a scientific, mining or mineral resources point of view including: geological sites of special scientific interest (SSSI), local geological sites (LGS), areas of current underground or opencast mining, and areas of designated mineral resources.

3.2.2.13 All baseline and survey data was captured within a Geographic Information System (GIS), together with the modified onshore export cable route and substation alignment. This information then informed the assessment of likely significant effects on various receptors within the study area. Appropriate mitigation measures were then determined.

Rochdale Envelope Parameters Considered in the Assessment

3.2.2.14 The range of parameters adopted within this assessment are summarised in Table 3.2-7 below. The parameters set out below define the "Rochdale Envelope" realistic worst case scenario for each likely significant effect. The actual requirements, in terms of dimensions, trench widths etc., may in reality be smaller.

Table 3.2-7 Rochdale Envelope Parameters

Potential Effect	Rochdale Envelope Scenario Assessed
Applicable to Construction, Operation and Decommissioning phases	
Changes to surface runoff patterns and land drainage systems	
Soil/subsoil compaction and reduced infiltration resulting in increases in localised overland flooding	
Physical deterioration in water bodies	

<table>
<tr><th>Potential Effect</th><th>Rochdale Envelope Scenario Assessed</th></tr>
<tr><td>Water quality deterioration in water bodies</td><td rowspan="11">Landfall: excavation and construction, possible permanent retaining wall and transitional pit.

Onshore export cable route
Cable Trench width: up to four trenches, each 4 m wide assuming individual trenches. Alternatively two trenches with two cables in each, each 6 m in width
Depth (m): Target 1 m trench depth (although slightly deeper burial at 1.2 - 1.5 m may be required to achieve cover in some locations)
Maximum working width: 60 m. Depends on number of trenches, worst case assumes four separate trenches
Installation Method:
A) Cable Plough;
B) Horizontal Direction Drilling (HDD) (landfall and water crossings); and
C) Open trench
Substations
MORL Surface area: 36,450 m^2
Transmission Owner (TO) Surface area: 45,900 m^2</td></tr>
<tr><td>Soil erosion of inclines and release into water environment</td></tr>
<tr><td>Loss of floodplain storage or conveyance capacity</td></tr>
<tr><td>Reduction in existing flood and coastal erosion management measures</td></tr>
<tr><td>Effects on Water Supplies (quality and quantity)</td></tr>
<tr><td>Effects on Aquifers (quality)</td></tr>
<tr><td>Alteration of Groundwater Levels</td></tr>
<tr><td>Alteration of Groundwater Flow</td></tr>
<tr><td>Effects on geologically important sites</td></tr>
<tr><td>Effects from Land contamination</td></tr>
<tr><td>Sterilisation of mineral reserves</td></tr>
</table>

3.2.2.15 The proposed cabling arrangement comprises a maximum of four cable trenches, with a maximum working width, worst case scenario, of 60 m. The modified export cable route from Inverboyndie to south-west New Deer is approximately 33 km in length.

EIA Methodology

3.2.2.16 The overall methodology involved defining the baseline scenario/conditions and considering the possible effects and their magnitudes and the receptors and their sensitivity, providing an overall assessment of the significance of each effect. Mitigation measures are also considered for each effect and the significance of the effect is reassessed after the mitigation measures are implemented. The methodology follows the Guidelines for Environmental Impact Assessment, produced by the Institute of Environmental Management and Assessment (IEMA).

3.2.2.17 For contaminated land the approach and methodologies used for the assessment are in accordance with the guidance contained within the Contaminated Land (Scotland) Regulations 2005 and the British Standard "Investigation of Potentially Contaminated Sites – Code of Practice", BS10175.

Determining the Sensitivity of the Resource/Receptor

3.2.2.18 Receptors and/or the receiving environment likely to be affected by the modified OnTI proposals have been identified within the defined study area. The sensitivity of the identified receptor/resource has been determined as follows:

Table 3.2-8 - Sensitivity of Potential Effects

Sensitivity	Definition of Examples
Very High Sensitivity	*Hydrology*
	Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC); SEPA Water Quality defined as High; Designated salmonid fishery and / or salmonid spawning grounds present; Watercourse widely used for recreation, directly related to watercourse quality (e.g. salmon fishery) within 2 km downstream; Conveyance of flow and material, main river > 20 m wide; and/or Active floodplain area with known risks of widespread flooding (e.g. in relation to a flood prevention scheme).
	Hydrogeology (water supplies and groundwater)
	Surface water abstractions for public drinking water supply; Groundwater abstractions for public drinking water supply; Private Water Supplies - surface water abstractions within 0-200 m; Private Water Supplies - groundwater spring abstractions within 0-100 m of construction activities; Groundwater and surface water abstractions >1,000 m³/d (within corridor); and/or Groundwater aquifer vulnerability classed between 4a-d and 5 in the SEPA vulnerability classification scheme.
	Geology and contaminated land
	Geology rare or of national importance as defined by SSSI or Regional Important Geological Site (RIGS); Human Health; Nationally important mineral reserves; and/or Groundwater aquifer vulnerability classed between 4d, 4c, 4b, 4a and 5 in the SEPA vulnerability classification scheme.
High sensitivity	*Hydrology*
	SEPA Water Quality defined as Good; Designated salmonid fishery and/or cyprinid fishery (Coarse Fish, including roach, carp, chubb, bream etc.); Watercourse used for recreation, directly related to watercourse quality (e.g. swimming, salmon fishery etc.); Conveyance of flow and material, main river 10-20 m wide; and/or Active floodplain area (Important in relation to flood defence).
	Hydrogeology

Sensitivity	Definition of Examples
	Large scale industrial surface water abstractions 500-100 m^3/d within 2 km downstream; Groundwater abstractions 500-1,000 m^3/d (within zone of influence of development); Private Water Supplies - surface water abstractions within 200-600 m; Private Water Supplies - groundwater spring abstractions within 100-400 m of construction activities; Private Water Supplies - groundwater borehole abstractions within 0-200 m of construction activities; Groundwater private water supply >10 m^3/d or serves >50 people; and/or Groundwater aquifer vulnerability classed as 3 in the SEPA vulnerability classification scheme.
	Geology and contaminated land
	Groundwater aquifer vulnerability classed as 3 in the SEPA vulnerability classification scheme.
Medium sensitivity	*Hydrology*
	SEPA Water Quality defined as Moderate; Occasional or local recreation (e.g. local angling clubs); Conveyance of flow and material, main river <10 m wide or ordinary watercourse >5 m wide; Existing flood defences; May be subject to improvement plans by SEPA; Designated cyprinid fishery, salmonid species may be present and catchment locally important for fisheries; and/or Watercourse not widely used for recreation, or recreation use not directly related to watercourse quality..
	Hydrogeology
	Industrial/ agricultural surface water abstractions 50-499 m^3/d within 2 km downstream; Groundwater abstractions 50-499 m^3/d; Private Water Supplies - surface water abstractions within 600->800 m; Private Water Supplies - groundwater spring abstractions within 400-800 m of construction activities; Private Water Supplies - groundwater borehole abstractions within 200-600 m of construction activities; and/or Groundwater aquifer vulnerability classed as 2 in the SEPA vulnerability classification scheme.
	Geology and contaminated land
	Locally important mineral reserves; Geological Conservation sites and LGS; and/or Groundwater aquifer vulnerability classed as 2 in the SEPA vulnerability classification scheme.

Sensitivity	Definition of Examples
Low sensitivity	*Hydrology*
	SEPA water quality defined as Poor or Bad; Fish sporadically present or restricted, no designated features; Receptors not used for recreation (e.g. no clubs or access route associated with watercourse); Watercourse <5 m wide – flow conveyance capacity of watercourse low – very limited floodplain as defined by topography, historical information and SEPA flood map; and/or Receptor heavily engineered or artificially modified and may dry up during summer months.
	Hydrogeology
	Industrial/ agricultural surface water abstractions <50 m^3/d within 2 km downstream; Groundwater abstractions <50 m^3/d; Private Water Supplies - groundwater spring abstractions within >800 m of construction activities; Private Water Supplies - groundwater borehole abstractions within 600->800 m of construction activities; and Groundwater aquifer vulnerability classed as 1 in the SEPA vulnerability classification scheme.
	Geology and contaminated land
	Geology not designated under a SSSI or RIGS or protected by specific guidance.

3.2.2.19 Derelict or uninhabited houses have been assigned a low sensitivity as they are not currently using water but may still have a private supply that could be used in the future. Uninhabited houses were those with empty rooms (no furniture, doors etc.) or those confirmed as being uninhabited by neighbours/owners of the property. Properties for which there was no response, i.e. no one in when the surveys were carried out, have been assigned a sensitivity based on their proximity to the centreline.

3.2.2.20 Where the point of abstraction (well, spring intake etc.) is unknown, the proximity of the abstraction to the centreline of the OnTI route has been taken as the distance between the centreline and the property served by the private water supply.

Determining the Magnitude of the Effect

3.2.2.21 The magnitude of the effect has been determined using the criteria in Table 3.2-9 below:

Table 3.2-9 Magnitude of Potential Impacts

Magnitude	Criteria	Description	Example
Major	Results in loss of attribute	Fundamental (long term or permanent) changes to geology, hydrology, water quality and hydrogeology Severe or irreversible moderate detrimental effect to human health. Irreversible detrimental effect to building structure.	Detrimental effect to nationally important geological feature. Loss of designated Salmonid Fishery. Loss of national level designated species / habitats. Changes in WFD water quality status of river reach. Significant loss flood storage/ increased flood risk. Pollution of potable source of abstraction compared to pre-development conditions. Loss of life, permanent disability, terminal illness. Building collapse or demolition.
Moderate	Results in a negative effect on integrity of attribute or loss of part of attribute	Material but non-fundamental and short to medium term changes to the geology, hydrology, water quality and hydrogeology Long-term minor or short-term moderate detrimental effect to human health.	Loss in productivity of a fishery. Contribution of a significant proportion of the discharges in the receiving water, but insignificant enough to change its water quality status. Reversible damage to nationally important geological feature. Temporary illness (months) following exposure to contaminant or gases. No increase in flood risk.
Minor	Results in minor negative effect on attribute	Detectable but non-material and transitory changes to the geology, hydrology, water quality and hydrogeology Short-term minor detrimental effect to human health.	Changes are of limited size and/or proportion. No increase in flood risk. Short-term temporary (days) illness following exposure to contaminant or gases.
Negligible	Results in a negative effect on attribute but of insufficient magnitude to affect the use/ integrity	No perceptible changes to the geology, hydrology, water quality and hydrogeology No appreciable impact on human health	Discharges to watercourse but no loss in quality, fishery productivity or biodiversity. No significant effect on the economic value of the receptor. No increase in flood risk. No change to human health.
Minor positive	Results in minor positive effect on attribute.	Minor reduction in risk to human health. Slight, local-scale improvement to the quality of potable groundwater or surface water resources.	Contamination linkages removed, or interrupted.

Magnitude	Criteria	Description	Example
Moderate Positive	Results in a positive effect on integrity of attribute or loss of part of attribute	Moderate reduction in risk to human health. Moderate local-scale improvement to the quality of groundwater or surface water resources.	Remediation of local small scale contaminated site. Contamination sources removed. Improvement for sensitive receptors.
Major positive	Results in positive improvements to attribute	Major reduction in risk to human health. Significant local-scale/ moderate to significant regional scale improvement to the quality of groundwater or surface water resources.	Remediation of large scale contaminated site. Contamination sources removed. Improvement to previously significantly contaminated areas. Improvement for sensitive receptors.

Significance of the Effect

3.2.2.22 The assessment of significance is based on the characteristics of the effect and the sensitivity of the receptor. By establishing the sensitivity of the resource/receptor and the magnitude of the effect the matrix shown in Table 3.2-10 below will be used to determine the significance level. For the purposes of this assessment effects of 'significant' or above are significant in terms of the EIA Regulations.

Table 3.2-10 Significance of the Effects

Receptor Sensitivity	Magnitude of Effect			
	Major	**Moderate**	**Minor**	**Negligible**
Very High	Major significance	Major significance	Minor significance	Minor significance
High	Major significance	Significant	Minor significance	Negligible
Medium	Significant	Significant	Minor significance	Negligible
Low	Minor significance	Minor significance	Negligible	Negligible

Assessment of Sensitivity of Receptors

3.2.2.23 The basis on which the sensitivity of receptors within the study area has been classified is shown in Table 3.2-11 below.

Table 3.2-11 Sensitivity of Receptors in Study Area

Receptor type	Description/Justification	Receptors Included	Sensitivity
Water body of high regional importance	Large water bodies with at least Moderate WFD classification	River Deveron, Boyndie Bay	Very high
Water body of local importance	Smaller water bodies with WFD classification	Burn of Boyndie, Burn of Fortrie, Burn of Fishrie, Craigston Burn, Burn of Monquhitter (Idoch Water)	High

Receptor type	Description/Justification	Receptors Included	Sensitivity
Minor water bodies	Small watercourses with no WFD classification	Burn of Bachlaw, Den Burn, Burn of Montbletton, Cot Burn, Aultan Burn, Burn of Swanford, Burn of Asleid	Moderate
Small land drainage channels	Small land drainage channels	Unnamed watercourses	Low
Private water supplies	Unknown source. Sensitivity assigned is worst case based on distance from centreline and proximity to mapped surface water course.	[PWS/N/2240]	Very high
	Unknown source. Sensitivity assigned is worst case based on distance from centreline.	[PWS/N/1060, PWS/N/2644, PWS/N/2163, PWS/N/0217, PWS/N/0653]	High
	Derelict/ uninhabited properties with no current active water supply.	[PWS/N/2505, PWS/N/0869, PWS/N/1113, PWS/N/2162, PWS/N/2132, PWS/N/2164, PWS/N/2225]	Low
	Private water supply: from spring between 100-400 m of centreline.	[PWS/N/0041, PWS/N/0032, PWS/N/0038]	High
	Private water supply: from spring between 400-800 m of centreline.	[PWS/N/0761]	Medium
	Private water supply from well between 0-200 m of centreline or substation.	[PWS/N/0063, PWS/N/2470, PWS/N/0763, PWS/N/1121, PWS/N/1065, PWS/N/1888, PWS/N/2165, PWS/N/2233, PWS/N/2129, PWS/N/1893]	High
	Private water supply: from well between 200-600m from centreline.	[PWS/N/0834, PWS/N/1045 and PWS-5951, PWS/N/1123, PWS/N/1100, PWS/N/0340, PWS/N/2475, PWS/N/2676, PWS/N/0347, PWS-5772, PWS/N/0422, PWS/N/2212, PWS/N/1896]	Medium
SEPA CAR Abstractions	Registered groundwater abstraction (10-50m^3/d)	Gellyhill Farm	Low
	Complex Licence to abstract groundwater (>2,000m^3/d)	MacDuff Distillery	Very high
	Complex Licences to abstract surface water (>2,000m^3/d)	Slackadale House Garniestone Farm	Very high
Public water supplies	Public water supply storage facility within 500m of centreline.	Scottish Water Brackans Reservoir	Very high
	Public/Industrial Water Supply	Fortrie Intake	Medium
Aquifers	Aquifers all assumed to be vulnerability classification 4a or 5.	All aquifers	High

Receptor type	Description/Justification	Receptors Included	Sensitivity
Statutorily protected sites	Geology of national importance as defined by SSSI	Whitehills to Melrose Coast SSSI	Very high
Non-statutorily protected sites	Locally important geological conservation sites	Cullen to Whitehills Coast and Tarlair to Gardenstown Coast Local Nature conservation sites.	Medium
Mineral reserves, including peat bogs	Locally important mineral reserves	Infrequent mineral veins in central section of the route, sand and gravel resources, peat bogs	Medium
Human health	Human Health	Construction workers, site users, site neighbours	Very high

Impact Assessment

3.2.2.24 The potential effects caused by the proposed works, pre-mitigation, identified in this section were considered the same for the three phases of development (Construction, Operation/Maintenance and Decommissioning) as the effect to the water body may occur at any of these stages.

3.2.2.25 The potential effects have been grouped into categories as follows:

- Changes to surface runoff patterns and land drainage systems;
- Physical deterioration in water bodies;
- Water quality deterioration in water bodies;
- Increased flood risk due to loss of floodplain storage or watercourse conveyance capacity;
- Increased flood risk due to placing new receptors in flood zones or due to compromising existing flood and coastal erosion management measures;
- Soil/subsoil compaction and reduced infiltration to aquifers/water supplies;
- Releases of sediment affecting water supplies;
- Alteration of groundwater levels;
- Alteration of groundwater flow paths;
- Accidental release of polluting materials affecting water supplies;
- Disturbance and movement of contaminated materials;
- Human health effects from contaminated land;
- Damage to geological sites;
- Sterilisation of mineral reserves.

3.2.2.26 These are discussed below. A summary of the detailed assessment made of the likely significance of each effect, if mitigation measures are not adopted, is provided in Table 3.2-12 at the end of this section. The following effects were considered for the construction, operation decommissioning phases:

Changes to Surface Runoff Patterns and Land Drainage Systems

3.2.2.27 The construction and decommissioning phases could affect local runoff patterns as a result of earth-moving operations, with potential for existing land drains and under-drainage systems to be damaged. This would likely cause localised flooding and contribute to soil erosion problems – an effect discussed in more detail below. It would also affect agricultural productivity, but at a localised level, depending on the areas drained by the specific field drains affected. During operation, poorly-maintained access routes have potential to have similar impacts. Similarly, unless the substations are provided with well-designed sustainable drainage systems, this could negatively impact on local land drainage systems. These effects are assessed as being of minor significance, even for water bodies of high sensitivity, because the impacts will be localised. For low sensitivity water bodies these effects are assessed to be negligible. This issue is assessed as being of minor significance for high sensitivity water supplies and negligible significance for low sensitivity water supplies.

Physical Deterioration in Water Bodies

3.2.2.28 If measures are not taken to safeguard existing water bodies, the construction, operation and decommissioning activities may damage river/watercourse banks leading to further bank and bed erosion with consequent deposition downstream. Whilst the effects are likely to be minor and localised in the context of water body as a whole, the WFD status of many of these watercourses is already compromised by physical modifications and such effects could contribute to a failure to meet WFD targets. These effects are likely to be temporary and localised, but could have longer-term impacts if not adequately mitigated. Pre-mitigation, these issues are assessed as being potentially of major significance for high sensitivity water bodies such as the River Deveron and of minor significance for low sensitivity water bodies.

Water Quality Deterioration in Water Bodies (WFD)

3.2.2.29 If specific measures are not taken to control sediment-laden runoff and or polluting matter from entering the watercourses at all phases of the scheme’s lifetime, this is likely to contribute to existing diffuse pollution problems, which may affect the watercourse achieving good status by the WFD target dates. This effect is assessed as being potentially of major significance for high sensitivity water bodies such as the River Deveron, unless mitigation is implemented. For low sensitivity water bodies this issue is assessed as being of minor significance pre-mitigation.

Increased Flood Risk Due to Loss of Floodplain Storage or Conveyance Capacity

3.2.2.30 Filling of floodplain areas, for example with temporary stockpiles, bunds or mounds, displaces floodwater, which may increase flood risk elsewhere. Similarly, if temporary or permanent watercourse crossings are badly-designed or maintained, this may increase flood levels, impacting local properties. This issue applies to all phases of the scheme, but the construction and decommissioning phases have most potential to cause problems. This issue is assessed as being of minor significance pre-mitigation, because of the limited scale of the likely impacts.

Increased Flood Risk Due to Placing New Receptors in Flood Zones or Due to Compromising Existing Flood and Coastal Erosion Management Measures

3.2.2.31 If no measures are taken to make sure that construction of vulnerable receptors in flood zones is avoided, then flood risk may be increased. Similarly, if existing flood defences, including the sand dunes, are not protected during construction, operation and decommissioning phases, then receptor exposure to the flood hazard may increase. This issue is assessed as potentially being of major significance for sensitive water bodies – for example if the sand dune natural flood defences were negatively affected. For low sensitivity water bodies the effects are assessed as being of minor significance, pre-mitigation.

Release of Sediment Affecting Water Supplies

3.2.2.32 The construction of temporary access tracks and excavation of cable trench and substation foundations, if not carefully managed, could lead to the release of sediment to surface watercourses or fines into aquifers (turbidity). This can have implications for water quality, especially public and private water supplies. This would apply to the decommissioning phase as well. In the context of this development the effect is assumed to be localised and minor in scale, due to the smaller watercourses that are impacted. These effects are assessed as being of minor significance to medium-high sensitivity water supplies and of negligible significance for low sensitivity water supplies, pre-mitigation.

Subsoil Compaction and Reduced Infiltration

3.2.2.33 During construction and decommissioning, the operation of heavy plant along the alignment of the OnTI and temporary access routes, and clearance of the area on which the two substations are to be located, may lead to compaction of superficial deposits which may reduce the infiltration capacity of the subsoil. This would reduce the amount of recharge able to reach the superficial and bedrock aquifers locally, which will have a knock on effect on any abstractions from these aquifers. In the context of the proposed development, the effect is assumed to be localised given the trench widths and relatively small substation footprint. This issue applies to a lesser extent to the operational phase, when the route will need to be accessed for inspection and maintenance purposes. These effects are assessed as being of minor significance to medium-high sensitivity water supplies; of negligible significance for low sensitivity water supplies, pre-mitigation.

Alteration of Groundwater Levels and Groundwater Flow Paths

3.2.2.34 The proposed development may affect groundwater levels and flows on a very local scale as a result of temporary dewatering (likely to be very shallow). This may however have an effect on groundwater abstractions close to the works. The excavation depth for both cable trench and substation foundations are likely to be shallow (<1.5m) and as a result are unlikely to have a great effect on either groundwater levels or flow patterns. In the context of the proposed development, the effect is assessed as being of minor significance to medium-high sensitivity water supplies; of negligible significance for low sensitivity water supplies, pre-mitigation.

Accidental Release of Contaminants to the Water Environment

3.2.2.35 During construction chemicals, concrete, bentonite and fuels are likely to be used and stored on site. This poses the risks of accidental spillage of contaminants during use or re-fuelling, and of leakage from storage tanks and containers. These contaminants therefore pose a risk to water quality in surface and groundwater bodies which are used for water supply. In addition, heavy rainfall could lead to further pollution incidents if spillages and leakages are not detected or cleared up. Contaminants thought to be contained on areas of hardstanding may be mobilised in surface runoff. The substation will include transformers that are likely to be oil-filled. Replacement and maintenance of the transformers will be associated with an attendant risk of oil spillages occurring. In the context of the modified OnTI, it is considered that these pollutants will not be present in large quantities. The effect is assessed as being of major significance for medium-high sensitivity water supplies and of minor significance for low sensitivity water supplies, pre-mitigation.

Disturbance and Movement of Contaminated Materials

3.2.2.36 A number of potentially contaminated sites have been identified during the desk study and site walkover. Such sites may contain contaminated soils and groundwater which may be mobilised during excavation of the cable trench and substation foundations, leading to pollution of surface and groundwater bodies, some of which are used for water supply. In the context of the modified OnTI development, the effects are considered to be localised and dependant on a sensitive receptor being located close to a contaminant source. These issues are assessed as having pre-mitigation effects of minor significance for all but very high sensitivity aquifers, for which the effects are assessed as being of major significance, pre-mitigation.

Human Health Impacts from Contaminated Land and Ground Gas

3.2.2.37 During the desk study and site walkover a number of potentially contaminated sites were identified within the study area. Such sites may contain contaminated soils, groundwater and ground gas. Construction workers could be exposed to contaminated soils and /or groundwater through inhalation, dermal contact, ingestion, or direct exposure during excavations works. Construction activities in contaminated ground may generate dust which could mobilise contaminants into the atmosphere and subsequently be inhaled by construction workers and nearby land users. There are areas of former peat bog which may be a source of ground gas. There is also risk of accumulating gases in confined spaces, such as trenches. Hazardous gases are also potentially explosive.

3.2.2.38 Human health is considered as a receptor of very high sensitivity. The pre-mitigation magnitude ranges from major adverse, direct, long term, permanent effect to a minor adverse, temporary, short term effect. The worst case scenario applies to loss of life for example due to accumulation of ground gases in confined spaces such as open trenches. The short term temporary effect may be a minor illness due to limited exposure to gases or contamination. This effect is therefore considered to be of major significance pre-mitigation.

Damage to Geologically Important Sites

3.2.2.39 The modified offshore export cable landfall site is bound on either side of Inverboyndie bay by a SSSI, Whitehills to Melrose Coast. Inverboyndie Bay itself does not fall within the SSSI designation. However, the landfall design and exact location on the beach and foreshore area has the potential to cause damage to the geological SSSI through excavation and movement of construction traffic. The SSSI as a designated site is considered as a receptor of very high sensitivity. Pre-mitigation effect have been assessed as significant.

Sterilisation of Mineral Reserves

3.2.2.40 A detailed assessment of the location of economically viable mineral reserves, other than a review of the findings from the Envirocheck report, has been made of the modified OnTI area. The BGS records identify rare mineral veins, with restricted extent, together with and evidence of historical and current open cast quarries. The construction of the cable trench and substation will have limited impact on the future exploitation of any potential mineral reserves at depth. The mineral reserves are locally important and assessed as a receptor of medium sensitivity. The pre mitigation magnitude is considered as a minor adverse direct, long term, permanent effect of minor significance.

3.2.2.41 The above impacts are summarised in Table 3.2-12 below. Each receptor is potentially impacted by a range of effects. For simplicity, Table 3.2-12 uses the data for the effect with the highest impact and which is of highest significance, pre-mitigation at the construction / decommissioning and operational phases.

Table 3.2-12 shows the assessment of the magnitude of the effect with the highest impact considered for each receptor and their significance pre-mitigation.

Receptor	Sensitivity	Pre-Mitigation Impacts Magnitude	Pre-Mitigation Significance
Construction and Decommissioning Phases			
Water body of high regional importance (River Deveron, Boyndie Bay)	Very high	Moderate	Major Significance
Water body of local importance (Burn of Boyndie, Burn of Fortrie, Burn of Fishrie, Craigston Burn, Burn of Monquhitter (Idoch Water)	High	Moderate	Significant
Minor water bodies (Burn of Bachlaw, Den Burn, Burn of Montbletton, Cot Burn, Aultan Burn, Burn of Swanford, Burn of Asleid)	Moderate	Minor	Minor significance
Small land drainage channels	Low	Negligible	Negligible
Brackan Service reservoir	Very high	Moderate	Major Significance
CAR Registered Abstraction (Gellyhill Farm)	Low	Moderate	Minor Significance
CAR Complex Licensed Abstractions (MacDuff Distillery, Slackadale House and Garniestone Farm)	Very High	Moderate	Major Significance
Private Water Supply [PWS/N/2240] **Unknown source. Sensitivity assigned is worst case based on distance from centreline and proximity to mapped surface water course.**	Very high	Moderate	Major Significance
PWS/N/1060, PWS/N/2644, PWS/N/2163, PWS/N/0217, PWS/N/0653] **Unknown sources. Sensitivity assigned is worst case based on distance from centreline.**	High	Moderate	Significant

Receptor	Sensitivity	Pre-Mitigation Impacts Magnitude	Pre-Mitigation Significance
[PWS/N/2505, PWS/N/0869, PWS/N/1113, PWS/N/2162, PWS/N/2132, PWS/N/2164, PWS/N/2225] **Derelict/ uninhabited properties with no current active water supply.**	Low	Moderate	Minor Significance
Private water supplies [PWS/N/0041, PWS/N/0032, PWS/N/0038] **from springs between 100-400 m of centreline.**	High	Moderate	Significant
Private water supply: [PWS/N/0761] from spring between 400-800 m of centreline.	Medium	Moderate	Significant
Private water supplies **[PWS/N/0063, PWS/N/2470, PWS/N/0763, PWS/N/1121, PWS/N/1065, PWS/N/1888, PWS/N/2165, PWS/N/2233, PWS/N/2129, PWS/N/1893] from wells between 0-200 m of centreline or substation.**	High	Moderate	Significant
Private water supplies **[PWS/N/0834, PWS/N/1045 and PWS-5951, PWS/N/1123, PWS/N/1100, PWS/N/0340, PWS/N/2475, PWS/N/2676, PWS/N/0347, PWS-5772, PWS/N/0422, PWS/N/2212, PWS/N/1896] from wells between 200-600m from centreline.**	Medium	Moderate	Significant
Public/Industrial Water Supply	Medium	Moderate	Significant
Aquifers all assumed to be vulnerability classification 4a or 5.	Very High	Moderate	Major Significance
White hills to Melrose Coast SSSI	Very high	Moderate	Significant
Cullen to Whitehills Coast and Tarlair to Gardenstown Coast Local Nature conservation sites.	High	Major	Significant
Mineral reserves	Low	Minor	Minor significance
Human health	Very high	Major	Major Significance
Operational phases			
Water body of high regional importance (River Deveron, Boyndie Bay)	Very high	Minor	Minor significance

Receptor	Sensitivity	Pre-Mitigation Impacts Magnitude	Pre-Mitigation Significance
Water body of local importance (Burn of Boyndie, Burn of Fortrie, Burn of Fishrie, Craigston Burn, Burn of Monquhitter (Idoch Water)	High	Minor	Minor significance
Minor water bodies (Burn of Bachlaw, Den Burn, Burn of Montbletton, Cot Burn, Aultan Burn, Burn of Swanford, Burn of Asleid)	Medium	Minor	Minor significance
Small land drainage channels	Low	Minor	Negligible
Brackan Service reservoir	Very high	Negligible	Minor Significance
CAR Registered Abstraction (Gellyhill Farm)	Low	Negligible	Insignificant
CAR Complex Licensed Abstractions (MacDuff Distillery, Slackadale House and Garniestone Farm)	Very High	Negligible	Minor Significance
Private Water Supply [PWS/N/2240] **Unknown source. Sensitivity assigned is worst case based on distance from centreline and proximity to mapped surface water course.**	Very high	Negligible	Minor Significance
PWS/N/1060, PWS/N/2644, PWS/N/2163, PWS/N/0217, PWS/N/0653] **Unknown sources. Sensitivity assigned is worst case based on distance from centreline.**	High	Moderate	Significant
[PWS/N/2505, PWS/N/0869, PWS/N/1113, PWS/N/2162, PWS/N/2132, PWS/N/2164, PWS/N/2225] **Derelict/ uninhabited properties with no current active water supply.**	Low	Negligible	Insignificant
Private water supplies [PWS/N/0041, PWS/N/0032, PWS/N/0038] **from springs between 100-400 m of centreline.**	High	Negligible	Insignificant
Private water supply: [PWS/N/0761] from spring between 400-800 m of centreline.	Medium	Negligible	Insignificant

Receptor	Sensitivity	Pre-Mitigation Impacts Magnitude	Pre-Mitigation Significance
Private water supplies **[PWS/N/0063, PWS/N/2470, PWS/N/0763, PWS/N/1121, PWS/N/1065, PWS/N/1888, PWS/N/2165, PWS/N/2233, PWS/N/2129, PWS/N/1893] from wells between 0-200 m of centreline or substation.**	High	Moderate	Significant
Private water supplies **[PWS/N/0834, PWS/N/1045 and PWS-5951, PWS/N/1123, PWS/N/1100, PWS/N/0340, PWS/N/2475, PWS/N/2676, PWS/N/0347, PWS-5772, PWS/N/0422, PWS/N/2212, PWS/N/1896] from wells between 200-600m from centreline.**	Medium	Negligible	Insignificant
Public/Industrial Water Supply	Medium	Negligible	Insignificant

Proposed Monitoring and Mitigation

3.2.2.42 The proposed monitoring and mitigation measures to address the pre-mitigation impacts described above are outlined below. All works affecting the water environment are likely to require a Controlled Activities Regulations (CAR) licence from SEPA. This process will involve providing the necessary evidence that the water environment will be adequately safeguarded by the design and construction process. The mitigation below is assessed as rendering all effects associated with geology, hydrology and contamination to being of negligible significance, with two exceptions. The accidental spillage of pollutants during construction, and potential effects on water supplies, is assessed as being of minor significance following mitigation, as is the effects from contaminated land and ground gas. The disturbance and mobilisation of contaminated material relating to aquifers and water supplies also has a residual impact of minor significance.

Avoidance of Sensitive Receptors

3.2.2.43 The primary mitigation technique is to route the cable and site the substations away from sensitive receptors. Many of the potential construction effects will be fully or partially mitigated by consultation with land and asset owners, site investigations and careful routing of the proposed OnTI/substation. Based on findings from the environmental baseline assessment, the following areas will be avoided for the final cable route where possible:

- Designated areas including geological and geomorphological SSSIs;
- Deep peat bogs. Peat is known to exist within the study area as detailed on geological maps. Where peat cannot be avoided, detailed peat depths surveys will be undertaken and the cable route will be designed such that the effect on the peat hydrology and carbon losses are minimised. The width of the cable trench will be minimised and peat will be extracted in such a manner to enable re-use for peat restoration;
- Private water supplies and abstractions. It may not be feasible to avoid all private water supplies and abstractions along the entire route, in particular in areas with many private water supplies clustered together. In such cases, a

more detailed investigation and risk assessment will be carried out to identify the exact location and potential zone of influence;

- Floodplains as shown in the SEPA Indicative River & Coastal Flood Map. Although avoidance of watercourses and floodplains is not entirely possible, the cable route will not run close to the river banks or over great distances parallel to rivers within the floodplain;
- Contaminated land as identified following detailed site investigations.

3.2.2.44 In general, the cable trenches will not be wider than strictly necessary and construction methods will be adopted to minimise additional (temporary) land take.

Detailed Site Investigations

3.2.2.45 Once the exact route selection is made within the wider study area, detailed site investigation will be carried out to assess risks from the potential existing land contamination identified. A site investigation strategy together with any additional research to further augment the conceptual site model will be developed for each individual site of potential existing land contamination along the route. The strategy for each will also be discussed with the Contaminated Land Officer at Aberdeenshire Council to give them an early opportunity to comment on the investigations proposed.

3.2.2.46 After implementation of the site investigation, detailed risk assessments will be carried out to understand the hazards posed by subsurface contamination, if present. In some instances, the hazards may be such that remedial works may be necessary to address the hazards prior to construction.

3.2.2.47 Geotechnical site investigations will be carried out to characterise the ground and groundwater conditions in relation to the design of the engineering works, de-watering requirements, foundation design and design of directional drilling for crossing of sensitive watercourses. These will be designed in conjunction with a specialist directional drilling contractor to reduce the risks as much as possible in relation to break out of bentonite.

3.2.2.48 The unknown sources of private water supply will be investigated further to confirm the source. This is particularly important for those located close to the substations, which may also be at risk during the operational phase.

3.2.2.49 The location of the abstraction licences within 500 m of the onshore export cable route centreline and substation locations also need to be ascertained and assessed. The potential presence of large abstractions for public consumption is a key uncertainty and risk.

3.2.2.50 A geomorphological study shall be carried out in Inverboyndie Bay to identify the most suitable location for the landfall infrastructure. Geo-environmental ground investigations shall be carried out at locations identified as potentially significantly contaminated, this should also include gas monitoring in areas of peat bogs. Gas protection measure may be required beneath the substation building if elevated ground gas is identified.

Environmental Design

3.2.2.51 The detailed design of the scheme will be developed for the cable route and sub-station using the data from the site investigations and risk assessments and EIA, in consultation with affected parties. The design will play a key role in reducing the scope for negative effects, as follows:

- The landfall design and exact location on the beach and foreshore area will be designed to minimise potential impacts on the SSSI;

- The design of crossings of sensitive water bodies will detail the cable passing a safe distance beneath the water body in question. Where HDD is used, drilling through the underlying rock or under granular deposits beneath water bodies will include sufficient cover to avoid leaching of lubricant or other polluting substances into the water bodies concerned;
- Where the infrastructure unavoidably passes adjacent to existing public or private water supplies, measures will be incorporated to ensure that the permanent works will pose no threat to these potable water sources;
- The design will ensure that, where the alignment unavoidably results in flood defence features being encountered – be these local riparian bunds or the sand dunes at Inverboyndie Bay – these defences are in no way compromised by the permanent works;
- Wherever there is a residual risk of flooding associated with the permanent works, that cannot be mitigated by the avoidance strategy, flood resistance or resilience measures, and attendant mitigation of off site impacts, will be used to ensure the permanent works is safe from flooding and will not increase flood risk elsewhere;
- Use of sustainable drainage systems for any permanent access roads and the substation compound to attenuate runoff to existing rates and prevent deterioration in the water quality of downstream watercourses. The drainage system will adopt sustainable drainage system (SUDS) principles as set out in best-practice guidance documents (Masters-Williams et al., 2001; Murnane et al., 2006; Water Research Centre et al., 2007; Woods Ballard 2007). All drainage measures will be designed to take account of existing land drainage systems;
- The risk of pollution occurring as result of operation and maintenance of the transformers will be mitigated by incorporation of sumps and, if necessary, secondary containment and/or bunding;
- Sterilisation of mineral reserves will be mitigated by undertaking consultation with the relevant stakeholders and key parties. Where mineral reserve sites cannot be avoided, and where there is potential for future extraction or possible sterilisation of these reserves, a design will be developed that minimises the sterilising effects.

Construction

Environmental Management Plan (EMP)

3.2.2.52 Use of the guidance listed in Section 3.2.1.65 will be made to develop a detailed Environmental Management Plan (EMP) in consultation with SEPA. This will be developed in conjunction with the contractor undertaking the engineering activities and monitoring. The EMP will also consider the actions to be taken in the event of encountering unexpected contamination and hazardous gases and how to deal with accidental pollution incidents, such as fuel spills.

3.2.2.53 Specific measures that are likely to be used to ensure that the significance of the residual effects are either of minor significance or insignificant, include the following:

- Any soils affected by construction activity will be protected from compaction. The default technique is likely to be for topsoil in the working area to be stripped, stored in a manner to prevent its deterioration/compaction and reinstated to the same levels as currently exist. Other techniques, such as temporary raft structures, may also be used;
- Dedicated site access routes and compound areas will be drained using drainage measures designed to ensure runoff is attenuated to existing levels and there are no routes for sediment or other pollutants to directly enter

watercourses. The system will be implemented prior and during the construction activities. Construction on steep slopes will, where possible, be avoided. The drainage system will adopt sustainable drainage system (SUDS) principles as set out in best-practice guidance documents (Masters-Williams et al., 2001; Murnane et al., 2006; Water Research Centre et al., 2007; Woods Ballard 2007). It will also provide measures to reduce erosion and prevent sediment laden runoff entering surface water. For example: adequately sized settlement lagoons could be constructed to allow settlement of sediments prior to discharge to groundwater or surface water. It is envisaged that the drainage system will incorporate some or all of the following components:

   - Diversion or cut-off drains to direct nearby runoff away from the construction area;
   - Drainage ditches, swales, infiltration areas etc. to capture runoff;
   - Distribute discharge points and drainage outfalls (surface water or groundwater) to reduce flow rates and volumes;
   - Check dams at regular intervals along ditches on a gradient to prevent high flow rates;
   - Settlement lagoons and sediment traps to prevent water pollution and act as a buffer area in case of pollution incidents; and
   - Temporary access track drainage to prevent surface water flooding.

- Any field under-drainage systems that are encountered on site will be reinstated to the same line and level to ensure that these systems continue to operate after the new infrastructure has been installed;
- Appropriate construction methods will be used for floodplain and watercourse crossings, with horizontal directional drilling (HDD) techniques used for larger watercourses such as the River Deveron. Where other techniques are used for crossing minor watercourses, such as temporary bridging structures or culverts, the physical alteration of the channel geometry will be reinstated to their pre-existing condition, with temporary erosion protection measures employed where necessary to ensure bank vegetation becomes fully re-established. To mitigate the disturbance to small watercourses as part of the construction of crossings, the following working methods will be adopted:
   - Minimise the duration over which watercourses are dammed to prevent backing up of flows and drying up of downstream channels;
   - Overpump flow where construction requires more than one day or where flows are significant;
   - Excavate cable trenches as narrow as possible across the river bed;
   - Restore river beds and banks using original soils and gravels where possible;
   - Provide additional scour and erosion protection to mitigate the risk of bare soils, and;
   - Develop site specific crossing methods take into account local issues and risks.
- Best practice construction site management will be adopted to minimise pollution risk from construction plant and materials including regular inspection of plant, storage of materials away from water bodies in spillage-proof containment areas and location of welfare and toilet facilities away from water bodies;

- The integrity of existing flood defences will be maintained throughout construction by ensuring these issues are captured in the construction stage EMP;
- Human health effects will be mitigated using the findings of the ground investigations and the personal protection equipment (PPE) provided where necessary. The EMP will include health and safety information of this kind. Confined space training will be given to construction workers potentially at risk from accumulating natural gases in open trenches and confined spaces, wherever such working methods cannot be avoided.
- Mitigation measures and best practice techniques shall be adopted to prevent unnecessary damage to the SSSI. Consideration shall be given to the plant traffic movements creating potential damage to the foreshore geology and to the potential for fuels / oil spills and leaks from machinery. A detailed method statement for foreshore construction shall be produced.

3.2.2.54 A site waste management plan will be developed to minimise waste (e.g. peat and soils, contaminated materials), reuse materials were possible (i.e. re-use agricultural and clean soils from trench excavation for backfill), segregate wastes (e.g. keep potentially contaminated soils separate from others) and ensure storage does not pose a risk of pollution from runoff / spillage.

3.2.2.55 A maintenance plan will be required for the operational phase which ensures that the water environment will not be affected by maintenance and repair operations. With the above measures in place, the residual effects of the scheme on the water environment will be either insignificant or of minor significance.

Environmental Monitoring

3.2.2.56 A groundwater and surface water monitoring programme will be carried out to obtain baseline data, as well as data during construction works for identified sensitive water environment receptors (e.g. water supplies, major watercourses).

3.2.2.57 These will be dependent on the final route alignment. The scope of this will be agreed with SEPA prior to implementation.

3.2.2.58 Once the final route alignment is determined detailed site investigations and review of water supplies in proximity to the route will be completed. If this identifies a potential effect on groundwater levels / flow regimes particularly in the vicinity of water supplies, a monitoring plan to review effects on groundwater levels / quality will be developed.

3.2.2.59 A surface water monitoring network for sensitive watercourses in relation to the final route alignment will be established six months prior to construction works. The monitoring network will consist of control monitoring points upstream of construction works as well as monitoring points downstream.

3.2.2.60 In addition to surface water monitoring, regular visual inspection of surface water management features such as field drainage outfalls and receiving watercourses will be carried out in order to establish whether there are increased levels of suspended sediment, erosion or deposition. It is likely that there will be an on-going need to maintain these structures (for example: by the removal of debris) to ensure they continue to function as designed.

3.2.2.61 Regular visual inspection of watercourses will be carried out during construction, particularly during periods of high rainfall but also during low flow conditions, in order to establish that levels of suspended solids have not been significantly increased by on-site activities.

3.2.2.62 Monitoring may also be required as a condition of any discharge consents, abstraction licences or other environmental regulations.

3.2.2.63 Following construction, earthworks reinstatement and, where appropriate, vegetation will be monitored to ensure stable ground surfaces become fully re-established. Similarly, areas where land drainage systems have to be reinstated during construction, following their inevitable disruption when the cable is installed, will be monitored to ensure that these systems are working satisfactorily.

Operation

3.2.2.64 The measures implemented during the construction phase will also address the operational phase effects to sensitive receptors. An Environmental Management Plan including health and safety information shall be kept with details of locations where contaminated materials and ground gases are known to occur along the route, so that maintenance works can be planned accordingly and PPE worn if necessary. Details of the SSSI will also be included to avoid any unnecessary damage during maintenance.

3.2.2.65 Regular inspections of the substations will be undertaken to ensure timely detection of any release of contaminants. The detailed design of the substations will include the use of bunds around chemical/ fuel storage areas and interceptor drains for any contaminants spilt in line with pollution prevention and design guidelines.

Decommissioning

3.2.2.66 As previously discussed, there is no specific schedule for the scope of activities for the decommissioning phase at present and as such it is not possible to identify detailed mitigation measures. However, as many of the potential effects could be similar and certainly no worse than that identified for the construction phase, the mitigation measures would be similar to those proposed for the construction phase.

3.2.3 Cumulative Impact Assessment

Summary

3.2.3.1 This section presents the results of assessment of the potential cumulative effects upon hydrology, geology and contaminated land arising from the modified OnTI as a whole in conjunction with other existing or reasonably foreseeable onshore developments and activities. MORL's approach to the assessment of cumulative effects is described in Chapter 1.3: Environmental Impact Assessment.

3.2.3.2 The other developments proposed in the area are, almost without exception, relatively minor, localised developments. For example, the windframs comprise installation of between one and three realtively small turbines and the anemometer masts are single masts. The largest proposal is for a 9.8 hectare solar farm.

3.2.3.3 A summary of the likely significant cumulative effects, assuming other developments in the area proceed at the same time as MORL's development, is provided in Table 3.2-13 below. In general, following mitigation, the cumulative effect on the hydrology, geology and hydrogeology is still assessed assessed to be negligible or of minor significance.

3.2.3.4 None of the individual effects were considered to increase due to potential cumulative effects, and hence no additional mitigation is required. In general terms it is considered that there is limited potential for cumulative effects to occur. Provided that each development is carried out with appropriate mitigation, adopting the best practices outlined in this report, the cumulative effect of the overall project, including these other developments, is assessed as being the same.

3.2.3.5 A key effect considered as part of all cumulative sites is water pollution due to construction activities. Although this could lead to a cumulative effect, the spatial distribution and the timing of the projects assessed makes it highly unlikely that there will be a significant cumulative effect on any surface water or groundwater body.

Table 3.2-13 Significant Cumulative Effects Summary

Effect	**Residual Significance Level for Modified OnTI**	**Whole Project Assessment: Modified TI +Telford, Stevenson and MacColl**	**Mitigation Method**
Construction			
All effects related to geology/contaminated land	Minor / negligible	Minor / negligible	None required beyond standard best practice
	Total Cumulative Impact Assessment	*If all of these developments proceed at the same time, the risk of contamination being encountered and waste being generated will be very slightly increased, but overall the cumulative impact is still considered to be of minor / negligible significance provided appropriate mitigation is implemented in accordance with the best practices outlined in this report.*	
All effects related to aquifers/water supplies	Minor / negligible	Minor / negligible	None required beyond standard best practice
	Total Cumulative Impact Assessment	*If all of these developments proceeded at the same time, the risk of aquifers and water supplies being affected by pollution will be slightly increased, but this is still only considered to be of minor / negligible significance, provided appropriate mitigation is implemented in accordance with the best practices outlined in this report.*	
All effects related to flood risk/surface water environment	Negligible	Negligible	None required beyond standard best practice.
	Total Cumulative Impact Assessment	*If all of these developments proceeded at the same time, the risk of surface water bodies being affected will be slightly increased, as will be the risks associated with localised land drainage and flood risk effects. However, overall, given the scale of these developments, the cumulative impact, with mitigation, is considered to be of negligible significance.*	
Operation / Maintenance			
All effects related to geology/contaminated land	Minor	Minor	None required beyond standard best practice
	Total Cumulative Impact Assessment	*The residual effects of minor significance – risk of pollution incidents occurring – remains of minor significance.*	
All effects related to aquifers/water supplies	Minor / Negligible	Negligible	None required beyond standard best practice
	Total Cumulative Impact Assessment	*Provided that each development is carried out with appropriate mitigation, the cumulative effect of all the development is considered negligible.*	
All effects related to flood risk/surface water environment	Negligible	Negligible	None required beyond standard best practice
	Total Cumulative Impact Assessment	*Provided that each development is carried out with appropriate mitigation, the cumulative effect of all the development is considered negligible.*	

Assessment of Cumulative Effects

Methodology

3.2.3.6 This section presents the results of assessment of the potential cumulative effects upon geology, hydrology and contaminated land arising from the modified OnTI in conjunction with other existing or reasonably foreseeable developments and activities. A whole project assessment has also been undertaken for the likely significant cumulative effects of the modified TI in conjunction with the three consented wind farms.

3.2.3.7 The scope of cumulative effects assessment considered planned developments which match the following criteria:

- Within 5 km of the onshore cable route;
- Those which are current (expired applications were excluded); and
- Those which are live (withdrawn or refused applications were excluded).

3.2.3.8 The scope of cumulative effects assessment highlighted that no planned developments were required to be considered for potential cumulative effects on the VERs identified within Table 3.2-13. The developments and activities considered at the scoping stage of the cumulative impact assessment are listed in Table 3.2-14 below for clarity.

3.2.3.9 There are eleven developments which are approved or pending planning permission within or in the close vicinity of the modified onshore export cable route corridor and substation site (Table 3.2-14 below).

Table 3.2-14. Developments and activities considered in detail in the cumulative impact assessment.

Name	Details	Evidence	Planning Status	Construction Timescale
Cairnhill Farm (Turriff, Aberdeenshire, AB53 5TN)	Erecton of 3 no Wind Turbines and Infrastructure Application received 2007.	No significant impacts during the operational phase on relevant receptors.	Operational	N/A
Gairnieston Farm (Turriff, AB53 5RP)	Erection of Wind Turbine and Associated Infrastructure (1 turbine). Application received 2007.	No significant impacts on any relevant receptors.	Operational	N/A
Backhill of Yonderton (Craigston, Turriff AB53 5PT)	Erection of 2 no. Enercon E70 2.3MY (4.6MW) Wind Turbines on 64 metre masts (Total Height 99.5 meters) and associated infrastructure. Application received 2010.	No significant impacts on any other relevant receptors.	Approved	Duration 3 – 5 Months. No start date confirmed.
South Colleonard (Banff, AB45 3TP)	Full Planning Permission for Erection of 1 no. Wind Turbine, Hub Height 55.6 metres (Total Height 79.6 metres) and Associated Infrastructure. Application Received 2012.	No significant impacts on any relevant receptors.	Pending	No information available.

Name	Details	Evidence	Planning Status	Construction Timescale
Knock Thunder Farm (Fiskaidly, Banff AB45 3AB)	Erection of 1 no. turbine of 77 m height and substation plus associated infrastructure. Application submitted 2013.	No significant impacts on any relevant receptors.	Pending	No information available.
Overhead Line Deviation (Upper Mains of Asleid Turriff)	Overhead line deviation. Application submitted 2004	No impact assessment prepared – insufficient information.	Approved	No information available.
Overhead Line (Sprottyneuk, New Deer, Turriff, Aberdeenshire, AB53 6XX)	Erection of 11kV Overhead Line (Retrospective). Application submitted 2006.	No impact assessment prepared – insufficient information.	Approved	N/A
33,000 Volt Line (Land at Strath of Brydock, Banff)	Installation of 33 kV Line. Application Granted 2008.	No impact assessment prepared – insufficient information.	Approved	No information available.
Reinforcement and Reinsulation of Existing Overhead Electricity Transmission Line (Land Rothienorman T Junction to Peterhead 275kV Electricity Sub Station) – near Mllbrex.	Notification under Electricity Act 1989 for Section 37 Notification for Reinforcement and Reinsulation of Existing Overhead Electricity Transmission Line to Upgrade Voltage from 275kV to 400kV. Application granted 2013.	No significant impacts on any relevant receptors.	Approved	Works anticipated to commence 2016-2018.
Cairnhill Farm (Turiff, AB53 5TN)	Installation of 2.4MW Solar Farm comprising 10000 PV Panels and Associated Infrastructure. Footprint 9.8 hecatres. Application granted 2013.	No significant impacts on any relevant receptors.	Approved	Duration: 2-3 weeks. No start date confirmed.

3.2.3.10 It can be concluded that these all comprise localised developments that will have no effects of significance to receptors potentially affected by the OnTI.

3.2.3.11 The solar farm at Cairnhill is situated within the study area and is the largest of the proposed developments. Its construction concurrently with the OnTI and substation could contribute to cumulative effects if the two developments are not coordinated. However, provided each party is made aware of the other's intentions, and incorporates appropriate mitigation into their proposals, as outlined in this assessment, the assessment of the significance of the cumulative impacts remains unaffected.

3.2.3.12 No further consideration of cumulative effects is given within this chapter.

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All guidance listed in Sections 3.2.1.63 and 3.2.1.64 of this report

however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Sensitive Receptor: Designated Coastal Habitats

3.1.3.74 The previous section concludes that there will be no significant effect on sediment transport rates through the combined wind farm developments as a result of their presence. The main effects on tidal currents and waves are generally confined to the wind farm site extents and are of a lower magnitude elsewhere. Therefore, there will therefore be no corresponding effect upon the rate of sediment supply to other parts of the Moray Firth.

3.1.3.75 The effect of the combined wind farm developments on wave height, period and direction at the location of designated coastal habitats has been considered in Chapter 13.1: Hydrodynamics (Wave Climate and Tidal Regime) in the MORL ES (2012), and was found to be not significant both in absolute terms and in the context of natural variability. There will, therefore, be no corresponding effect upon the rates or directions of nearshore sediment transport at these locations.

3.1.3.76 There will therefore be no effect on the form or function of designated coastal habitats.

3.1.3.77 A small magnitude of change within the range of natural variability is therefore assessed to arise in areas of low to medium sensitivity, resulting in an effect of **minor significance**.

3.1.3.78 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller blockage presented by individual OSPs (jackets instead of GBS foundations) and the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Total Cumulative Impact (all developments)

3.1.3.79 The potential for cumulative impacts with the BOWL development and WDA is considered to be limited, with a small magnitude of change anticipated to occur but within the range of natural variability in areas of low sensitivity. The total cumulative effect will therefore remain very similar to that assigned to the cumulative assessment of the Modified OfTI and Telford, Stevenson and MacColl wind farms (i.e. **minor significance**).

Scour Effects

Modified OfTI and Telford, Stevenson and MacColl wind farms

Sensitive Receptor: The Smith Bank

3.1.3.80 There is a potential for scour to develop around obstacles to flows, where and when scour protection is not applied. Where scour protection is applied, scour might possibly occur in the interim period between installation of the object and placement of the protection.

3.1.3.81 Using empirical relationships described in Whitehouse (1998), the equilibrium scour depth for each foundation type resulting from waves and currents, both alone and in combination has been calculated for different foundation sizes. Results have also been up-scaled for the cumulative numbers of foundations in the combined wind farm developments and the total area found as a proportion of the wind farm(s) area.

3.1.3.82 The largest total footprint of scour is assessed to occur in response to the lowest rated GBS scenario (i.e. the greatest number of turbines) at less than 1% of the total area of the three consented wind farms. Other foundation types and rating scenarios result in a smaller relative area of effect.

3.1.3.83 Where and when exposed, export and inter-array cable infrastructure might also induce some local scour but only of a very small magnitude (order of 10s of centimetres). Scour associated with gravity based OSP foundations is of a similar order to that of the turbine foundations and is considered as a minor increase to the values already presented.

3.1.3.84 The effects of the foundations in causing scour are of a small to medium magnitude relative to the range of naturally occurring variability in seabed level but do not cause the normal range of water depths to be exceeded. The effects of scour are limited to only a small proportion of the area of each of the three consented wind farms and an even smaller proportion of the area of the Smith Bank.

3.1.3.85 A small to medium magnitude of change that does not exceed the range of natural variability is therefore assessed to arise in an area of low sensitivity. The resulting cumulative effect is therefore of **minor significance**.

3.1.3.86 The nature, duration and significance of the predicted potential cumulative effect including the modified OfTI are the same as previously assessed in the MORL ES (MORL, 2012). The magnitude and extent of the predicted potential effect are however reduced, due to the smaller number of OSPs being installed (2 instead of 8) and the smaller number of turbines actually consented in the three wind farms than previously assessed.

Total Cumulative Impact (all developments)

3.1.3.87 The potential for cumulative impacts with the BOWL development and WDA is considered to be limited, with a small magnitude of change anticipated to occur but within the range of natural variability in areas of low sensitivity. The total cumulative effect will therefore remain very similar to that assigned to the cumulative assessment of the Modified OfTI and Telford, Stevenson and MacColl wind farms (i.e. **minor significance**).

Decommissioning

3.1.3.88 Following removal of the wind farms and offshore transmission infrastructure, there is no potential for any modification to the baseline wave and tidal regimes. The worst case scenario of all wind farm infrastructure present is considered in the preceding section. The effect of less than the total amount of infrastructure present at an intermediate stage in the decommissioning process will be (proportionally) less than that reported (as not significant) for the operational phase of the development (i.e. of a small magnitude and within the range of natural variability).

3.1.3.89 It is considered that the methods likely to be employed during decommissioning will be of a similar general nature but overall less energetic and disturbing a smaller volume of sediment than previously assessed in relation to construction. Therefore, the types of effect from decommissioning and their significance can only be considered to be similar to or less than that already provided above (either **negligible significance** or of **minor significance**).

3.1.4 References

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