

## 8 Environmental Impact Assessment, Mitigation and Management

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## 8.1 Introduction

The activities and events associated with the SWAP 3D Seismic Survey have been determined based on the activities described within Chapter 4: Project Description; and the potential for Interactions with the environment identified. In accordance with the impact assessment methodology (see Chapter 3), ESIA Scoping has been undertaken to identify activities that may be “scoped out” from the full impact assessment process based on event magnitude and the likely receptor interaction. In addition, existing controls and mitigation have been identified which include routine procedures and design measures that will be used to ensure that activities are consistent with environmental expectations.

Those activities that have not been scoped out have been assessed on the basis of event magnitude and receptor sensitivity, taking into account the existing controls and mitigation, and impact significance determined. Monitoring and reporting activities undertaken to confirm that these controls are implemented and effective, as well as additional mitigation and monitoring to further minimise impacts, where required, are provided.

Assessments of socio-economic impacts and cumulative and transboundary and accidental events have also been undertaken and are provided in Chapters 9 and 10, respectively.

## 8.2 Scoping

The SWAP 3D Seismic Survey activities and associated events that have been scoped out due to their limited potential to result in discernible environmental impacts are presented in Table 8.1. The scoping process has used professional judgement based on prior experience of similar Activities and

Events for similar projects in Azerbaijan and across the world. In some instances, scoping level quantification/numerical analysis has been used to justify the decision. Reference is made to relevant quantification, numerical, survey and/or monitoring reports in these instances.

**Table 8.1: “Scoped Out” SWAP 3D Seismic Survey Activities**

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for “Scoping Out”
<b>Offshore Survey Activities</b>			
3D_E -R1	Emissions to atmosphere (non GHG) from survey and support vessel engines <sup>1</sup>	<b>Section 4.7.1</b>	<ul style="list-style-type: none"> <li>• Emissions of non-greenhouse gases (GHG) to atmosphere will arise from the operation of the survey and support vessel engines.</li> <li>• Estimated volumes of non GHG emissions (NO<sub>x</sub>, CO, SO<sub>x</sub> and non-methane volatile organic hydrocarbons) are 225, 31, 31 and 9 tonnes respectively over the survey duration (refer to Table 4.8 of Chapter 4).</li> <li>• NO<sub>x</sub> (comprising nitrogen oxide (NO) and nitrogen dioxide (NO<sub>2</sub>)) is the main atmospheric pollutant of concern, based on the larger predicted emission volumes as compared to other pollutants (sulphur oxides or SO<sub>x</sub>, CO and non-methane hydrocarbons) and the potential to impact human health and the environment.</li> <li>• Air quality along the coastline of the Absheron region is variable with background NO<sub>2</sub> concentrations varying between 12µg/m<sup>3</sup> in the vicinity of Sangachal<sup>2</sup>, and 38µg/m<sup>3</sup> in the vicinity of Bibiheybat<sup>3</sup> in 2013, just below the annual EU standard for NO<sub>2</sub> of 40µg/m<sup>3</sup>. Significantly higher NO<sub>2</sub> concentrations (up to 120 µg/m<sup>3</sup>) have been recorded within Baku itself.</li> <li>• The SD2 ESIA considered the impact of NO<sub>x</sub> emissions associated with mobile drilling rig engines while drilling one well in the north flank of SD Contract Area approximately 70km offshore and within approximately 10km of the SWAP 2D Seismic Survey Area. The volume of NO<sub>x</sub> emissions was estimated as 157 tonnes.</li> <li>• The air quality modelling undertaken to assess the air quality impact to onshore receptors confirmed that annual average NO<sub>x</sub> concentrations would increase by up to 1.5µg/m<sup>3</sup> within 1km and by up to 1µg/m<sup>3</sup> within 10km of the rig location.</li> <li>• While the NO<sub>x</sub> emissions released during the 3D Seismic Survey are estimated to be of a similar magnitude they will be released from vessel sources operating within 0km to approximately 15km of the coastline. Emissions released will be distributed across a wide area and increases in annual average NO<sub>x</sub> concentrations onshore due to vessel emissions are expected to be very small and indistinguishable from existing background concentrations.</li> <li>• Vessels will be well maintained and, where available, will use good quality, and low sulphur fuel (typically &lt;0.05% weight).</li> <li>• The volume of fuel used by the vessels over the duration of the survey will be recorded and reported to the Ministry of Environment and Natural Resources (MENR) at the end of the survey.</li> </ul> <p><b>Conclusion:</b> Based on efficient operation and regular maintenance there is deemed to be no discernible impact to onshore receptors</p>

<sup>1</sup> Greenhouse gas (GHG) emissions are discussed within Chapter 10: Cumulative, Transboundary and Accidental Events.

<sup>2</sup> URS, 2013. Shah Deniz Stage 2 Project ESIA.

<sup>3</sup> MWH, 2014, Air Quality Governance in the ENPI East Countries National Pilot Project – Azerbaijan “Improvement of Legislation on Assessment and Management of Ambient Air” - Draft National Strategy on AQAM, report funded by the European Union.

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for "Scoping Out"
3D_E -R2	Underwater sound from survey and support vessel engines	Section 4.5.1	<ul style="list-style-type: none"> <li>• In water depths greater than 5m deep the survey and support vessels will be operating 24 hours a day throughout the survey period (up to 9 months commencing in March). In water depths less than 5m the survey and support vessels will operate during daylight hours.</li> <li>• The vessels to be used are much smaller in terms of engine size to those typically used to support drilling activities within the Azerbaijan sector of the Caspian Sea.</li> <li>• Assessment of underwater sound generated by drilling support vessel engines undertaken for the SD2 ESIA indicated that, during winter, fish and seal injury thresholds (refer to Section 6.3.1.2 below for further details) were not reached at any distance from the source. Mild avoidance reactions in seal and fish were limited to distance of no more 72m from the source.</li> <li>• The SWAP 3D Seismic Survey Area is located within a busy shipping area, through which international and regional shipping passes regularly in addition to numerous smaller vessels that provide offshore support to the oil and gas industry. Hence sound from vessel engines will contribute to background underwater sound levels throughout the year and the sound from the 3D Seismic Survey and support vessel engines is unlikely to be distinguishable.</li> </ul> <p><b>Conclusion:</b> Underwater sound from vessel engines is unlikely to be distinguishable from existing background underwater sound levels.</p>
3D_E -R4	Discharges to sea from vessels	Section 4.7.2	<ul style="list-style-type: none"> <li>• Discharges from vessels will comprise deck drainage and wash water.</li> <li>• In accordance with the PSA, deck drainage and wash water will be discharged from vessels as long as no visible sheen is observable. Oily and clean drainage or wash water will be segregated; clean water will be discharged to sea and oily water transported to an appropriate onshore disposal facility.</li> </ul> <p><b>Conclusion:</b> The low volume of these discharges in accordance with the relevant standards over the short duration of the survey period is not anticipated to result in any discernible impact to the marine environment.</p>
3D_E -R5	Disturbance due to use of lighting on the vessels (greater than 5m water depth)	Section 4.5.1	<ul style="list-style-type: none"> <li>• The survey and support vessels operating in water depths greater than 5m will operate during daylight hours only.</li> <li>• The survey and support vessels operating in water depths greater than 5m will carry appropriate navigation lights for operating during night-time and periods of poor visibility. The level of lighting will be in compliance with safety regulations at sea to ensure operational safety needs.</li> <li>• Light has the potential to affect fish and seals within the marine environment if they are present in the area, attracting seals and fish to the light source. However given the adoption of the existing controls including the soft start (refer to Section 8.3 below) it is considered unlikely that seals and fish will be present in the vicinity of the seismic vessel during operations. The underwater sound from the support vessel engines will also likely dissuade fish and seals from approaching these vessels.</li> <li>• When survey and support vessel operations occur in the hours of darkness, exterior vessel lighting will be limited to that necessary for ensuring safe operations.</li> </ul> <p><b>Conclusion:</b> Potential for disturbance to receptors in the marine environment due to use of lighting on the vessels</p>

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for "Scoping Out"
3D_E -R6	Disturbance to marine cultural heritage from vessel movement, node deployment and retrieval	Section 4.8.1.2	<p>considered to be very small.</p> <ul style="list-style-type: none"> <li>There are two known marine cultural heritage sites within the 3D Seismic Survey Area, submerged in shallow waters (Bayil Castle and Zira Fortress). The locations of these sites are well known and mapped on navigational charts.</li> <li>There is potential for other submerged marine cultural heritage sites across the 3D Seismic Survey Area.</li> <li>Prior to the seismic survey being undertaken offshore reconnaissance and seabed hazard surveys will be undertaken, including marine side scan, magnetometer, and multi-beam bathymetry surveys to confirm the location of seabed hazards to allow the survey team to plan to avoid these.</li> <li>There will be no anchoring or node deployment in areas of the seabed where marine cultural heritage sites are known or suspected to be located.</li> </ul> <p><b>Conclusion:</b> Potential for physical interaction between the survey activities and marine cultural heritage considered to be very small.</p>
3D_E -R7	Disturbance to benthic environment from vessel movement, operation of seismic source, node deployment and retrieval	Section 4.5.1	<ul style="list-style-type: none"> <li>The offshore seismic survey will be undertaken in three different ranges of water depths (0-2m, 2-5m and greater than 5m) across the five Priority Areas using the vessel and seismic sources described within Chapter 4 Section 4.5.1.</li> <li>In addition seabed nodes will be deployed as described within Section 4.5.1.5. These nodes will rest on the seabed and then be retrieved for re-use, download and charging.</li> <li>Benthic fauna present across the survey area is generally of low abundance and diversity with the same species of invertebrates recorded across all areas except within Baku Bay where no benthic fauna was observed near to the shoreline;</li> <li>The extent and diversity of benthic flora (comprising seagrass and algae) across the survey area is not known however seagrass in particular may be present in less turbid waters. Previous surveys near to Sangachal have shown seagrass in this area to be tolerant to disturbance (including physical removal) and to recover quickly.</li> <li>Interaction between the nodes, which are inert, and the benthic environment for the short duration the nodes are present on the seabed is expected to be very small.</li> <li>Vessels and energy sources will be operated in line with procedures which include minimal seabed clearance;</li> <li>Low volume energy sources will be used in shallow waters; 300 cu in volume for 0 – 2m and 680 cu in for 2 – 5m</li> <li>Therefore it is considered unlikely that the benthic environment will be physically affected by the operation of the seismic energy source.</li> </ul> <p><b>Conclusion:</b> Impacts to the ecological benthic environment associated with offshore survey activities are expected to be insignificant.</p>
3D_E -R8	Mobilisation of seabed contamination from vessel movement, node deployment and retrieval	Section 4.5.1	<ul style="list-style-type: none"> <li>As described above there is potential for the seabed environment in shallow waters to be physically affected by the seismic energy source, disturbing any existing contamination in the sediments.</li> <li>In addition nodes laid on the seabed may disturb existing contamination present.</li> <li>As discussed within Chapter 5 Section 5.5.3.2 Total Hydrocarbon Concentrations (THCs) in sediments are</li> </ul>

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for "Scoping Out"
			<p>known to vary significantly across the survey area with the highest mean concentration recorded near Baku Bay.</p> <ul style="list-style-type: none"> <li>• Heavy metal concentrations in sediments were found to vary little, except in localised areas where higher concentrations were recorded (e.g. Baku Bay).</li> <li>• Water quality analysis across the survey area has indicated no evidence of persistent contamination, with the exception of Baku Bay where localised areas of high concentrations of heavy metals, hydrocarbon contamination and coliforms (considered to be due to waste water discharge into Baku Bay) were identified</li> <li>• It is expected that the deployment and retrieval of nodes will result in the brief mobilisation of any contamination within the sediment into the water column in a localised area with sediment returning to the seabed in the same location. Widespread mobilisation of existing contamination into the water column is not anticipated.</li> </ul> <p><b>Conclusion:</b> Potential for offshore survey activities to have a measurable effect on water quality or mobilise existing seabed contamination considered unlikely.</p>
<b>Main Base and Sub Bases Activities</b>			
3D_E -R10	Vessel fit out and mobilisation	Section 4.6.1	<ul style="list-style-type: none"> <li>• As described within Chapter 4 Section 4.6 the specialist source vessels, onshore sources and nodes will be shipped to country from the USA and Malaysia.</li> <li>• Vessels and equipment will undergo fit out, audits and checks at the main base before the survey commences.</li> <li>• To minimise potential for introduction of invasive species to the Caspian Sea imported vessels and equipment will undergo thorough cleaning in line with relevant guidelines<sup>4</sup>.</li> </ul> <p><b>Conclusion:</b> Potential for introduction of invasive species to the Caspian Sea is considered to be insignificant.</p>
3D_E -R11	Refuelling, supply and maintenance activities during onshore and offshore surveys	Section 4.6	<ul style="list-style-type: none"> <li>• It is planned that, during the offshore survey, larger vessels (Geotigers) will refuel at sea from supply vessels every 3-4 days and all other vessels will refuel at the base or sub base every day. Strict refuelling procedures will be followed.</li> <li>• It is planned, during the onshore survey, that smaller light vehicles<sup>5</sup> will refuel at public fuel stations and larger vehicles will be either refuelled from a fuel tank at Hovsan Port in a dedicated refuelling area or at one of the 3 sub-bases by fuel truck. The refuelling area at Hovsan Port will be located on an impermeable surface and will include a bund wall capable of holding the content of the fuel tank. The refuelling area will be located away from storm water sewers, channels and water courses and will be protected from weather conditions. The refuelling procedure at the sub-bases will be conducted using drip-trays.</li> <li>• Existing utilities (i.e. electricity, gas, water and telecommunications) at the main base and sub base will be used. No additional or temporary utilities are planned to be used for the project at the main base or sub bases.</li> <li>• Maintenance activities will predominantly be undertaken in warehouses and workshops, minimising</li> </ul>

<sup>4</sup> Such as Marine Biofouling And Invasive Species: Guidelines For Prevention And Management, Global Invasive Species Programme & UNEP Regional Seas Programme, 2008

<sup>5</sup> i.e. the 4 x 4 and SUV support vehicles and support trucks

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for "Scoping Out"
			<p>potential sound and disturbance.</p> <ul style="list-style-type: none"> <li>The main base and sub bases are existing facilities located in industrial areas equipped with operational jetties. During pre-mobilisation, storage and warehouse facilities, loading and unloading facilities at the main base will be renovated as required and fit for purpose.</li> <li>The main base and sub bases will be used for supply and maintenance activities mainly during daylight hours.</li> </ul> <p><b>Conclusion:</b> Potential for impacts to the surrounding environment associated with refuelling, supply and maintenance activities onshore and offshore considered to be insignificant.</p>
3D_E -R12	Use of Main Base and Sub Base Utilities (drainage, sewage, power and telecommunications)	Section 4.6.1	<ul style="list-style-type: none"> <li>All support activities at the main base and sub-bases will make use of the existing utilities (i.e. electricity, gas, water and telecommunications).</li> <li>Black and grey water generated at the main base/sub-bases will either: <ul style="list-style-type: none"> <li>Be sent to a municipal sewage treatment plant for treatment and disposal via mains sewer pipes, or</li> <li>If the base/sub base has an operational sewage treatment plant that discharges treated effluent to the environment, the base/sub base operator will be responsible for agreeing the discharge standard with the MENR and maintaining the discharge permit conditions stipulated by the MENR.</li> </ul> </li> <li>Drainage water from areas in the base/sub base(s) in which hazardous materials are stored and routinely used will be contained and will be collected by road tanker, handled as liquid waste and removed from site. Where the base operator has an agreement with the MENR for discharge of drainage from areas where hazardous materials are storage or used, they will be responsible for maintaining the discharge permit conditions stipulated by the MENR.</li> </ul> <p><b>Conclusion:</b> Discharge of treated sewage and discharge of drainage from areas where hazardous materials are stored or used from the main base/sub bases will be in accordance with MENR requirements.</p>
<b>Onshore Survey Activities</b>			
3D_E -R13	Emissions to atmosphere (non GHG) from survey and support vehicles engines	Section 4.7.1	<ul style="list-style-type: none"> <li>Emissions of non-greenhouse gases (GHG) to atmosphere will arise from the operation of the survey and support vehicle engines.</li> <li>Estimated volumes of non GHG emissions (NO<sub>x</sub>, CO, SO<sub>x</sub> and non-methane volatile organic hydrocarbons) are 47, 11, 2 and 5 tonnes respectively over the survey duration (refer to Table 4.8 of Chapter 4).</li> <li>As stated above (3D_E-R1) air quality varies along the coastline of the Absheron region with background NO<sub>2</sub> concentrations have been recorded varying between 12µg/m<sup>3</sup> in the vicinity of Sangachal, 38µg/m<sup>3</sup> in the vicinity of Bibiheybat and up to 120µg/m<sup>3</sup> with road traffic and heavy industry considered to be the main emission sources.</li> <li>Emissions from the onshore survey vehicles will occur over a 9 month period and will be distributed across the onshore 3D Seismic Survey Area. The relatively small volume of emissions is not expected to contribute to a significant or noticeable increase in pollutant concentrations at receptors and will rapidly disperse in the atmosphere.</li> <li>Vehicles movements will be minimised as far as possible.</li> <li>All survey vehicles and equipment will be modern and well maintained in accordance with written procedures</li> </ul>

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for "Scoping Out"
			<p>based on the manufacturer's guidelines, applicable industry code, or engineering standards to ensure efficient and reliable operation.</p> <p><b>Conclusion:</b> Based on efficient operation and regular maintenance there is deemed to be no discernible impact to onshore receptors</p>
3D_E -R15	Generation of dust due to vehicle movements and seismic operations	Section 4.5.2	<ul style="list-style-type: none"> <li>• The movement of the survey vehicles and operation of the seismic source has the potential to give rise to dust, particularly during the summer months and in areas of no or sparse vegetation.</li> <li>• The Absheron Region is a semi arid environment and naturally arising wind blown dust is a known nuisance issue across the region including within Baku.</li> <li>• Vehicle speed limits established for different road surfaces will be adhered to at all times during the survey.</li> <li>• Onshore survey personnel will be provided with environmental awareness training that includes measures designed to minimise dust.</li> <li>• The survey will be undertaken using the existing road network, but it will also be necessary to travel off road to access receiver and source points. Off road vehicle movements will be minimised as far as practical.</li> <li>• Vehicles movements will be minimised as far as possible.</li> </ul> <p><b>Conclusion:</b> No discernible impact on human and ecological/biological receptors due to dust generation is expected</p>
3D_E -R17	Potential mobilisation of contamination due to survey vehicle movements	Section 4.5.2	<ul style="list-style-type: none"> <li>• As described within Chapter 5 Section 5.4.2.2 there is potential for contaminated areas (polluted with hydrocarbons) across the onshore 3D Seismic Survey Area particularly in areas of disturbed ground and therefore potential for survey vehicles to mobilise this contamination if they pass through it;</li> <li>• Prior to the Seismic Survey commencing a programme of pre-planning surveys will be undertaken. These activities will inform the Seismic Survey design, including further informing the positioning of survey lines and which of the proposed onshore methods are suitable for which areas (i.e. vibroseis or OnSeis);</li> <li>• As part of the pre-planning surveys areas of visible contamination will be identified and mapped so that survey can, as far as possible, be planned to avoid areas of contamination.</li> <li>• Onshore survey personnel will be provided with environmental awareness training that includes measures designed to minimise potential mobilisation of contamination.</li> <li>• The survey will be undertaken using the existing road network, but it will also be necessary to travel off road to access receiver and source points. Off road vehicle movements will be minimised as far as practical.</li> <li>• Vehicles movements will be minimised as far as possible.</li> </ul> <p><b>Conclusion:</b> No discernible impact to the terrestrial environment due to mobilisation of contamination is expected</p>
<b>All Activities</b>			
3D_E -R21	Waste management	Section 4.7.3	<ul style="list-style-type: none"> <li>• Offshore, all waste streams (including sanitary waste) will be appropriately segregated, stored in fit for purpose containers/tanks on-board the vessels and transferred to waste facilities provided at the main base and the sub-bases.</li> <li>• Onshore, hazardous and non-hazardous wastes will be segregated and stored in designated areas and fit for purpose containment at the main base and sub-</li> </ul>

ID	Activity / Event	Ch. 4 Project Description Reference	Justification for "Scoping Out"
			<p>bases. Waste will then be sent to BP approved waste management facilities for recycling/reuse, treatment and /or disposal under rigorous Duty of Care protocols.</p> <ul style="list-style-type: none"> <li>Waste management will be undertaken in line with the national regulatory requirements, good international industry practices, BP's AGT Regional Waste Manual and 3D Seismic Survey Waste Management Plan.</li> <li>An outline of the applicable waste management principles are described in Chapter 11: Environmental and Socio-Economic Management.</li> </ul> <p><b>Conclusion:</b> Waste will be managed as described within Chapter 11: Environmental and Socio-Economic Management. No discernible impact to the marine or terrestrial environment expected.</p>

The SWAP 3D Seismic Survey routine and non-routine activities and their associated events assessed in accordance with the full impact assessment process are presented in Table 8.2.

**Table 8.2: "Assessed" SWAP 3D Seismic Survey Activities**

ID	Activity / Event	Ch. 4 Project Description Reference	Event	Receptor
3D_E-R3	Operation of offshore survey seismic sound sources	Section 4.5.1.4	Underwater sound	Marine Environment (fish and seals)
3D_E-R9	Operation of offshore survey and support vessels	Section 4.5.1	Direct/indirect effect to wildlife	Terrestrial Environment (Birds and Protected Areas)
3D_E-R14	Operation of onshore survey and support vehicles and seismic sources	Section 4.5.2.1	In air sound	Terrestrial Environment (human receptors)
3D_E-R16			Potential disturbance/damage to cultural heritage	Terrestrial Environment (cultural heritage)
3D_E-R18			Groundborne vibration	Terrestrial Environment (human receptors and residential/community structures)
3D_E-R19			Direct/indirect effect to wildlife	Terrestrial Environment (ecology)
	Loss of habitat			

The sections below present an assessment of these Activities in accordance with the impact assessment methodology and significance criteria as presented within Chapter 3 of this ESIA.

## 8.3 Impacts to the Marine Environment (Water Column) Due to Seismic Operations

Underwater sound, resulting from the use of seismic sources, as described in Section 4.5.1 of Chapter 4, has the potential to impact biological/ecological receptors (specifically seals and fish) in the marine environment.

### 8.3.1 Mitigation

To minimise risk of potential impacts occurring from underwater sound a number of control measures have been included in the project design. These include the following:

1. Seismic source array design
  - The volume and arrangement of air guns, for each of the seismic vessels has been carefully selected to produce the minimum sound levels required for successful data acquisition.
2. Temporal and spatial avoidance of sensitive areas
  - The 3D SWAP Seismic Survey has been scheduled such that activities would avoid the most sensitive seal periods. Thus, the survey will be undertaken in accordance with the agreed project schedule (refer to Chapter 4 Figure 4.1); the key elements of which are described below;
    - The survey within Priority Area 2 will commence in the north and move south in order to reduce potential overlap with seal presence.
    - Within Priority Area 4 the survey will commence in the east and move west to avoid peak sensitivity of migrating seals.
3. Soft-start and Marine Mammal Observation (MMO) protocols
  - Vessel crew will be trained in MMOs;
  - In water depths greater than 2m the soft-start and marine mammal observation protocol will be followed;
  - To reduce the potential risk of direct physical harm (especially hearing damage) to seals, the Project will establish a Mitigation Buffer Zone of 500m around sound sources for visual observations of seals;
  - Seismic source soft-start (or ramp up) procedures will be implemented for the survey and conducted each time activation of the source array recommences after a period of inactivity (greater than 20 minutes);
  - Prior to the seismic source being activated using a soft-start procedure, marine mammal monitoring will be conducted for 30 minutes to observe (dedicated) whether there are any seals within the Mitigation Buffer Zone. If seals are sighted, the soft-start procedure will be delayed for at least 20 minutes to ensure no seals are within the Mitigation Buffer Zone;
  - Trained vessel crew will conduct ongoing visual observations of Caspian seal in the vicinity of the survey vessel. All observations will be logged including location of sighting and number of individuals seen. Daily and final summary reports will be prepared;
  - Survey vessels will not intentionally approach seals for the purposes of casual (recreational) marine mammal viewing which may result in disturbance; and
  - In water depths less than 2m the soft-start procedure is not required. There will however, be marine mammal observation at the start of any seismic activation or where there has been a period of seismic inactivity greater than 20 minutes. If a seal is observed within the 500m Mitigation Buffer Zone activation will be delayed until there has been a period of 20 minutes without seal observations.
4. The offshore survey will be undertaken using suitably experienced and qualified vessel operators.
5. Risks will be re-assessed and a contingency plan developed in the event that the seismic survey is delayed.

### 8.3.2 Event Magnitude

Underwater sound modelling was undertaken to help inform the evaluation of the magnitude of potential impacts of underwater sound to the biological receptors in the marine environment (seals and fish). The modelling evaluated the sound output from the proposed seismic source arrays and resultant sound propagation based on water depth and other physical environmental conditions representative of the survey area. The results of the sound modelling were compared to available sound threshold criteria to assess potential injury and behavioural impacts for Caspian seals and fish.

#### 8.3.2.1 Sound Threshold Criteria Associated with Potential Impacts to Fish and Seals

Responses of marine mammals and fish to underwater sound have been studied and reported within the scientific literature over many years with threshold criteria developed for a number of species and groups of species. Thresholds are usually proposed in terms of one or more different sound level metrics and for different levels of potential impact ranging from physiological damage to behavioural responses.

Sounds can be described with various acoustic metrics, including sound pressure levels (SPL) and sound exposure levels (SEL). The former is the instantaneous pressure and the latter a measure of received sound energy. This is further complicated as sound pressure level can be defined as a peak, peak-to-peak, zero-to-peak or RMS (root mean square) values.

Most available literature provides a mixture of both measures, although many sound sources are primarily described in pressure level units. To accommodate these two measures, and to account for all relevant acoustic features that may affect marine organisms, dual criteria thresholds for sound exposures, using both sound pressure and sound exposure levels, are often defined. For an exposed individual, whichever criterion is exceeded first (i.e. the more precautionary of the two measures) is used as the operative injury criterion.

Thresholds related to physiological damage typically consider potential permanent and temporary effects on hearing where animals exposed to sufficiently intense sound exhibit an increased hearing threshold (i.e. poorer sensitivity) for some period of time following exposure. This is called a sound-induced threshold shift and the amount of shift is determined by the receptors activity at the time of hearing the sound, the distance between a sound and species in combination with the amplitude, duration, frequency content, temporal pattern, and energy distribution of sound exposure relative to the hearing sensitivity of the species and background sound levels. Hearing threshold shifts may be permanent (PTS) or temporary (TTS) and thus physiological impacts are generally considered at these two levels:

- **Permanent threshold shift** is a permanent, irreversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. This is considered to be auditory injury.
- **Temporary threshold shift** is a temporary, reversible increase in the threshold of audibility at a specified frequency or portion of an individual's hearing range above a previously established reference level. Based on data from cetacean TTS studies<sup>6</sup>, a TTS of 6 dB is considered the minimum threshold shift clearly larger than any natural variation in an animal's normal hearing.

Behavioural responses have been investigated in a number of studies, mostly laboratory (for fish)<sup>7</sup> or aquarium based (for seals<sup>8</sup>), though some studies in the natural environment have been attempted.

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<sup>6</sup> Southall, B.L., Bowles, A.E., Ellison W.T., Finneran J.J., Gentry, R.J., Greene Jr, C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, J.W., Thomas, J.A, and Tyack P.L. 2007. Marine mammal noise exposure criteria: initial scientific recommendations. *Aquatic Mammals*, Vol 33, 411–522.

<sup>7</sup> For example, monitoring the response of fish in cages during piling activity in Southampton: Nedwell, J.R., Turmpenny, Langworthy, J.W. and Edwards, B. 2004. Measurements of underwater noise during piling at the Red Funnel Terminal, Southampton, and observations of its effect on caged fish. Report Reference: 558 R 0207

Nevertheless, the available data from a wide range of studies shows there is significant variability in behavioural responses in all marine receptors and that these responses are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. This reality has generally limited efforts to formulate broadly applicable behavioural response criteria for marine receptors.

Thus, for each case, there are uncertainties related to whether PTS occurs in marine mammals as a result of sound from seismic surveys (and none has so far been observed) and there are necessarily significant limitations associated with all the thresholds given because of the limited species and number of individuals that have been studied. Nevertheless, current thresholds are based on the best currently available evidence, as described in more detail below.

### **Thresholds for Fish**

There are no specific threshold data available for potential impacts of seismic sound sources on fish and so currently available injury guidelines for fish are based on predictions derived from the effects of impulsive sounds, particularly piling<sup>9,10</sup>.

The dual exposure criteria (sound pressure and sound exposure levels) in fish, relate to potential mortal injury, recoverable injury and TTS, thresholds which have been developed by Popper et al<sup>8</sup> based on the following fish hearing categories:

- High hearing sensitivity fish, particularly herring and related species (Clupeidae), use the swim bladder in hearing;
- Medium sensitivity fish including sturgeon have a swim bladder but it is not used in hearing; and
- Low sensitivity fish, particularly sharks and rays, do not have any gas filled organs.

TTS have been demonstrated in some fish but there are high levels of variability in the duration and magnitude of the shift depending on many factors, including the intensity and duration of sound exposure, the species and life stage of fish. Thus, TTS thresholds for all fish (regardless of hearing ability) are based on a number of studies including the exposure of several riverine species to a seismic airgun array and as such are highly precautionary.

There are no reliable thresholds for fish behavioural changes and impacts are generally considered in terms of high, medium or low risk to fish populations rather than individual fish. A small number of studies have investigated fish population responses and whilst fish catchability rates in the vicinity of seismic surveys have been seen this pattern has not been observed in all studies<sup>11,12,13</sup>. In another investigation no impact was observed on herring feeding behaviour. In the latter study the unexpected lack of a response to the seismic survey was interpreted as a combination of a strong motivation for feeding by the fish, a lack of suddenness of the seismic sound source stimulus, and an increased level of tolerance to sound from the source array. Investigating potential fish behavioural impacts is an

<sup>8</sup> Jillian M. Sills, Brandon L. Southall, Colleen Reichmuth. 2014. Amphibious hearing in spotted seals (*Phoca largha*): underwater audiograms, aerial audiograms and critical ratio measurements, *The Journal of Experimental Biology* (2014) 217: 726-734

<sup>9</sup> Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D., Bartol, S., Carlson, T., Coombs, S., Ellison, W.T., Gentry, R., Halvorsen, M.B., Løkkeborg, S., Rogers, P., Southall, B.L., Zeddies, D. and Tavalga, W.N. 2014. ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.

<sup>10</sup> Fisheries Hydroacoustic Working Group (FHWG), 2008. US National Marine Fisheries Service interim criteria for pile driving.

<sup>11</sup> Dalen, J. og Raknes, A. 1985. Skremmeeffektar på fisk frå 3-dimensjonale seismiske undersøkingar. Havforskningsinstituttet, rapport nr. FO 8504, Bergen. 22 s. Dalen, J. 2007. Effects of seismic surveys on fish, fish catches and sea mammals. Report for the Cooperation Group – Fishery Industry and Petroleum Industry. Report no.: 2007-0512.

<sup>12</sup> Engås, A., Løkkeborg, S., Ona, E., and Soldal, A.V. 1996. Effects of seismic shooting on local abundance og catch rates of cod (*Gadus morhua*) og haddock (*Melanogrammus aeglefinus*). *Can. J. Fish. Aquat. Sci.* 53(10): 2238-2249.

<sup>13</sup> Løkkeborg, S. and Soldal A.V. 1993. The influence of seismic exploration with air guns on cod (*Gadus morhua*) behaviour og catch rates. *ICES Mar. Sci. Symp.*, 196: 62-67.

important area of on-going research<sup>14</sup> but in the meantime the assessment of behavioural responses in fish should be context specific.

There are no thresholds for benthic invertebrates and plankton because they are not considered to be sensitive to sound from seismic source arrays. The thresholds adopted for the underwater sound study are presented in full within Appendix 8A.

### **Thresholds for Seals**

There is no empirical data available on the sound levels and exposure durations that would induce PTS in marine mammals. Instead, thresholds for PTS in marine mammals have been estimated from measurements of TTS in marine mammals, and on patterns of TTS growth and its relation to PTS in other mammals. Data on the effects of sound on terrestrial mammals can be useful in considering the effects on marine mammals because of similarities in morphology and functional dynamics among mammalian cochleae.

As such, it is generally accepted that a sound exposure capable of inducing a TTS of 40 dB (40 dB re 1 µPa in water or 40 dB re 20 µPa in air) will cause PTS-onset in marine mammals. However, owing to the limited availability of relevant data on TTS and PTS, the extrapolation procedures underlying these estimations are precautionary. In addition, there are no empirical data concerning the levels of single pulses that would lead to TTS-onset and so thresholds have been estimated from non-pulse sounds.

The minimum exposure criterion for injury in seals is the level at which a single exposure is estimated to cause onset of PTS and is measured by SPL. The second of the dual criteria is an SEL measure that refers to the sound energy accumulating over a period of time for a moving receptor.

Thresholds have been developed for both the onset of PTS and TTS in seals (based on TTS data for the northern elephant seal and harbour seal). A recent study<sup>15</sup> based on the underwater hearing ability of two captive spotted seals suggested that their hearing ability was similar to harbour seals, and lower than other Arctic species tested (i.e. harp and ringed seals). This suggests that harbour seals are an appropriate proxy for other ice seals, such as the Caspian seal for which no specific thresholds exist.

With regard to behavioural reactions, indicative thresholds have been developed for seals based on a very small number of studies of ringed, spotted and bearded seals. The thresholds relate to the onset of avoidance behaviour, limited disturbance and low level disturbance in seals due to impulsive sound. Based on the limited data on pinnipeds in water exposed to multiple pulses, exposures in the ~150 to 180 dB re: 1 µPa range (RMS values over the pulse duration) generally have limited potential to induce avoidance behaviour in pinnipeds. Only received levels exceeding 190 dB re: 1 µPa are likely to elicit responses, although this was demonstrated in ringed rather than Caspian seals<sup>6</sup>. Table 8.3 presents the threshold criteria for fish and seals.

For seals, due to the transient nature of a single pulse, the most severe behavioural reactions will usually be temporary responses, such as startle, rather than prolonged effects, such as modified habitat utilization. A transient behavioural response to a single pulse is unlikely to result in demonstrable effects on individual growth, survival, or reproduction. Consequently, for the unique condition of a single pulse, an auditory effect is used as a de facto disturbance criterion. It is assumed that significant behavioural disturbance might occur if sound exposure is sufficient to have a measurable transient effect on hearing (i.e., TTS-onset). This approach is expected to be precautionary because TTS at onset levels is unlikely to last a full diel cycle or to have serious biological consequences during the time TTS persists.

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<sup>14</sup> For example, see the recent Joint Industry Programme (JIP) initiative to investigate impacts of seismic surveys on fish behaviour: [http://science.leidenuniv.nl/index.php/ibl/newsitem/october\\_2015\\_start\\_of\\_new\\_sound\\_impact\\_project\\_on\\_fish/](http://science.leidenuniv.nl/index.php/ibl/newsitem/october_2015_start_of_new_sound_impact_project_on_fish/)

<sup>15</sup> Sills, J.M., Southall, B.L. and Reichmuth, C. 2014. Amphibious hearing in ringed seals (*Pusa hispida*): underwater audiograms, aerial audiograms and critical ratio measurements. *The Journal of Experimental Biology*. Vol 217, 726-734.

**Table 8.3 Threshold Criteria for Fish and Seals**

Impact	SPL dB re 1 µPa (peak unless stated otherwise)	SEL dB 1 µPa <sup>2</sup> .sec
<b>Fish</b>		
Potential mortal injury in fish with low hearing sensitivity exposed to impulse sound	213	219
Recoverable injury in fish with low hearing sensitivity exposed to impulse sound	213	216
Potential mortal injury in fish with medium hearing sensitivity exposed to impulse sound	207	210
Recoverable injury in fish with medium hearing sensitivity exposed to impulse sound	207	207
Potential mortal injury in fish with high hearing sensitivity exposed to impulse sound	207	207
Recoverable injury in fish with high hearing sensitivity exposed to impulse sound	203	207
TTS in all fish exposed to impulse sound	-	186
<b>Caspian Seal</b>		
Permanent Threshold Shift (PTS)	218	186
Temporary Threshold Shift (TTS)	212	171
Avoidance Behaviour	190 (rms)	-
Limited Disturbance	150-180 (rms)	-

### 8.3.2.2 Underwater Sound Modelling

In order to determine a more accurate estimate of underwater sound the source levels for each of the three types of source arrays (i.e. associated with the Very Shallow Gun Array (VSGA), Bubbles and Geotiger vessels) were calculated close to the array based on sound output of the individual source elements. The total acoustic output for the whole array at a given field location is determined by summing the pressure contributions in Pascals from individual source elements while also taking into account the propagation loss over the distance between the source elements and the field location. The sound propagation computer models BELLHOP and RAM were then used to model sound propagation from the source array taking into account the environmental conditions that can affect sound propagation. The bathymetry of the seabed in the 3D Seismic Survey Area was constructed using bathymetry data contained in the ETOPO1 database<sup>16</sup> and oceanographic (temperature and salinity) data for the months March to October taken from the World Ocean Atlas. Once the results had been calculated for a stationary source and receptor a summation method was used to take into account the moving energy source and moving receptor.

The purpose of the modelling was to estimate sound level variation with distance from the source in terms of the various metrics associated with threshold criteria and then calculate the distance from the seismic source at which sound levels would decrease to below each of the relevant thresholds discussed above. This then provides the distance within which the potential acoustic effects to fish and seals may occur should they be present.

The sound source level for each vessel's array, based on far field assumptions only, was estimated as follows:

- 191.8 dB re 1 µPa @ 1m for the VSGA;
- 226.9 dB re 1 µPa @ 1m for Bubbles; and
- 237.9 dB re 1 µPa @ 1m for Geotiger.

<sup>16</sup> Amante, C. and Eakins, B. W. 2009. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-24,19.  
December 2015  
Draft

However, this method does not consider the near field interaction effects between individual source elements and can lead to an estimate of source level which can be in excess of the actual level by up to 20 dB. Taking into account the near-field interaction effects a more realistic representation of the sound source characteristics was calculated to be:

- 185 dB re 1  $\mu$ Pa @1m for the VSGA;
- 219 dB re 1  $\mu$ Pa @1m for Bubbles; and
- 229 dB re 1  $\mu$ Pa @1m for Geotiger arrays.

Modelling scenarios have been developed based on a number of key factors; individual vessels, multiple vessels operating simultaneously, the distance between operating vessels (worst case (minimum distance), which are rarely expected to occur and more typical cases (median distance)) and the schedule of activities. Based on these factors modelling has been undertaken for Priority Areas 2 and 4 only based on their sensitivity for Caspian Seals and fish (see Section 5.5.6.3). Table 8.4 below presents the scenarios modelled. These are also illustrated within Figure 8.1 and Figure 8.2. Full details of the sound modelling programme can be found in Appendix 8A.

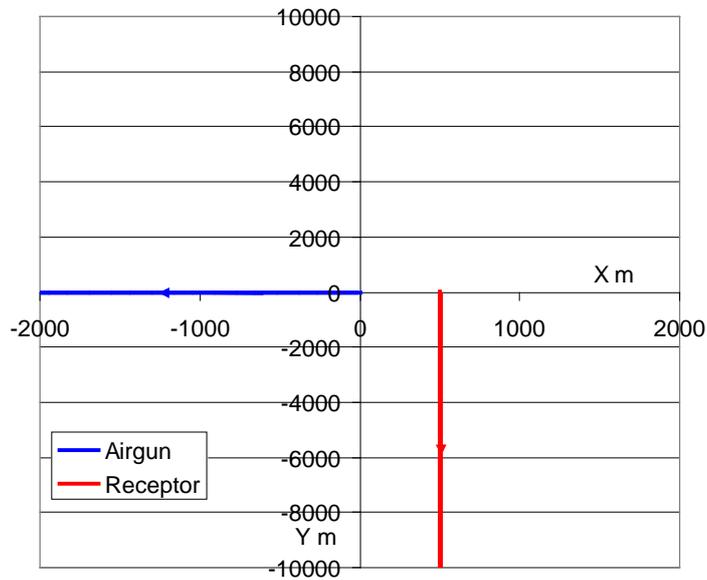
**Table 8.4: Underwater Sound Modelling Scenarios**

Scenario	Water Depths Vessels Operating In			Survey Vessels and Separations
	0-2m	2-5m	5->25	
<b>Single Vessel Scenarios</b>				
1	✓			Very Shallow Source Array (VSGA)
2		✓		Bubbles
3			✓	Geotiger 2
4			✓	Geotiger 4
<b>Combined Vessel Scenarios</b>				
CO1	✓*			VSGA 1 to VSGA 2 - 200 m
MS2		✓	✓	Bubbles to Geotiger 2 – ~1000 m Bubbles to Geotiger 4 - ~2000 m Geotiger 2 to Geotiger 4 – 1000 m separation and 2000m offset Bubbles and Geotigers travelling in opposite directions Receptor start position offset 500 m from Bubbles start position Receptor moving away from all vessels
MS3		✓	✓	Bubbles to Geotiger 2 – ~1500 m Bubbles to Geotiger 4 - ~2200 m Geotiger 2 to Geotiger 4 – 2000 m separation and 2000m offset Bubbles and Geotigers travelling in opposite directions Receptor start position offset 500 m from Bubbles start position Receptor moving away from all vessels
MS6		✓	✓	Bubbles to Geotiger 2 – ~2000 m Bubbles to Geotiger 4 - ~3200 m Geotiger 2 to Geotiger 4 – 5000 m separation and 2000m offset Bubbles and Geotigers travelling in opposite directions Receptor start position offset 500 m from Bubbles start position Receptor moving away from all vessels
MS7		✓	✓	Bubbles to Geotiger 2 – ~4000 m Bubbles to Geotiger 4 - ~4500 m Geotiger 2 to Geotiger 4 – 8000 m separation and 2000m offset Bubbles and Geotigers travelling in opposite directions Receptor start position offset 500 m from Bubbles start position Receptor moving away from all vessels
MS9		✓	✓	Bubbles to Geotiger 2 – 6000 m Bubbles to Geotiger 4 - ~6300 m Geotiger 2 to Geotiger 4 – 12000 m separation and 2000m offset Bubbles and Geotigers travelling in opposite directions Receptor start position offset 500 m from Bubbles start position

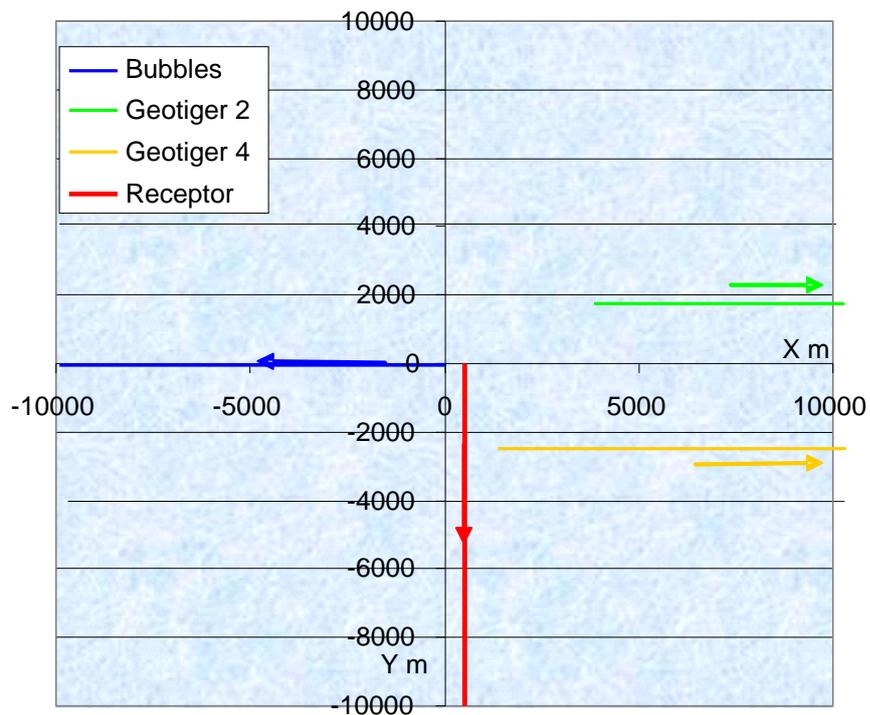
				Receptor moving away from all vessels
<b>Note:</b> *The results showed that when multiple VSGA arrays are used (up to 2 per depth zone in each Priority Area), the SPLs and SELs generated are unlikely to meet thresholds indicating PTS or TTS in pinnipeds or fish.				

The modelling scenarios commence with each source array moving at a speed of 2.3 m/s with a receptor moving away from the vessel at a speed of 2.6 m/s for pinnipeds or 0.2 m/s for fish. An offset distance between the vessel and the receptor, of 500m is assumed for all model scenarios as the Mitigation Buffer Zone (the exclusion zone for seals) is 500m. The scenarios are illustrated in Figures 8.1 for single vessels and Figure 8.2 for multiple vessels. In all cases the travel directions of the vessels and receptors are relative to the modelling grid rather than the actual survey area.

**Figure 8.1: Relative Locations and Paths of Receptor and Source Array During Single Vessel Modelling**



**Figure 8.2: Relative Location and Path Of Source Array And Receptor During Multiple Vessel Deployments**



## Fish

The results of the sound modelling, indicating the predicted distance at which sound levels would be below the SPL or SEL thresholds for potential impacts to fish are shown in Table 8.5. Detailed results of the modelling are presented in Appendix 8A.

**Table 8.5: Summary of Potential Impact Ranges for Fish Species Exposed to Seismic Sound for Priority Area 2 and Priority Area 4**

Impact	Threshold value	Distance m		
		VSGA	Bubbles	Geotiger
<b>Sound Pressure Level - dB<sub>peak</sub> re 1 µPa</b>				
Potential mortal injury in fish with low hearing sensitivity exposed to impulse sound Recoverable injury in fish with low hearing sensitivity exposed to impulse sound	213	<1	4	27
Potential mortal injury in fish with medium hearing sensitivity exposed to impulse sound Potential mortal injury in fish with high hearing sensitivity exposed to impulse sound Potential mortal injury in fish eggs and larvae exposed to impulse sound Recoverable injury in fish with medium hearing sensitivity exposed to impulse sound	207	<1	12	40-42
Recoverable injury in fish with high hearing sensitivity exposed to impulse sound	203	<1	12	60
<b>Sound Exposure Level - dB 1 µPa<sup>2</sup>.sec</b>				
Potential mortal injury in fish with low hearing sensitivity exposed to impulse sound	219	<1	<1	15
Recoverable injury in fish with low hearing sensitivity exposed to impulse sound	216	<1	10	25
Potential mortal injury in fish with medium hearing sensitivity exposed to impulse sound	210	<1	20	40
Potential mortal injury in fish with high hearing sensitivity exposed to impulse sound Recoverable injury in fish with high hearing sensitivity exposed to impulse sound Recoverable injury in fish with medium hearing sensitivity exposed to impulse sound	207	<1	20	55
TTS in all fish exposed to impulse sound P2 TTS in all fish exposed to impulse sound P4	186	<1	105	385-485 495-700

The modelling indicates that sound levels in the shallowest waters (0 to 2m) where the VSGA vessel will be operating are very low and that all thresholds for fish are only reached at a distance of less than 1m from the source (Table 8.5). For the vessel operating in water depths between 2 and 5m, potential mortal or recoverable injury may occur if fish are present within a distance of up to a maximum of 20m away from the source. Also, TTS in all fish is only predicted from modelled SEL values at distances up to a maximum of 105m from the Bubbles source and between 385 and 700m from Geotigers.

As described within Chapter 4 of the ESIA, the 3D Seismic Survey will involve up to 5 vessels working simultaneously in the same Priority Area. As such, modelling has been undertaken to consider the combined sound fields in terms of Peak SPL and cumulative SEL for multiple vessels for a number of vessel/receptor start locations and simplified movement scenarios. The modelled maximum SPL and cumulative SEL results for the various scenarios are shown in Table 8.6.

**Table 8.6: Maximum SPLs and SELs for Fish Exposed to Multiple Sources**

Scenario Description	Threshold metric	Predicted SPL/SEL ranges	
		Fish	
		P2 <sup>1</sup> June-Aug	P4 <sup>2</sup> Sep-Oct
<b>MS2.</b> Bubbles to Geotiger 2 – ~1000 m Bubbles to Geotiger 4 - ~2000 m Geotiger 2 to Geotiger 4 – 1000 m separation and 2000m offset	SPL	172.6-177.9	179.9-178.2
	SEL	179.9- <b>187.2</b>	188.0- <b>192.4</b>
<b>MS3.</b> Bubbles to Geotiger 2 – ~1500 m Bubbles to Geotiger 4 - ~2200 m Geotiger 2 to Geotiger 4 – 2000 m separation and 2000m offset	SPL	166.7-174.3	174.1-177.1
	SEL	174.9-184.8	184.8- <b>192.1</b>
<b>MS6.</b> Bubbles to Geotiger 2 – ~2000 m Bubbles to Geotiger 4 - ~3200 m Geotiger 2 to Geotiger 4 – 5000 m separation and 2000m offset	SPL	159.9-168.1	168.4-173.5
	SEL	166.2-178.0	178.5- <b>190.6</b>
<b>MS7.</b> Bubbles to Geotiger 2 – ~4000 m Bubbles to Geotiger 4 - ~4500 m Geotiger 2 to Geotiger 4 – 8000 m separation and 2000m offset	SPL	158.8-166.7	166.7-172.5
	SEL	163.7-174.5	175.2- <b>190.5</b>
<b>MS9.</b> Bubbles to Geotiger 2 – 6000 m Bubbles to Geotiger 4 - ~6300 m Geotiger 2 to Geotiger 4 – 12000 m separation and 2000m offset	SPL	158.4-166.3	166.3-171.3
	SEL	162.8-173.4	173.8- <b>189.2</b>
<sup>1.</sup> The results are presented as a range of values which cover the survey period of June to August.			
<sup>2.</sup> The results are presented as a range of values which cover the period of September to October			

Sound modelling results shown in Table 8.6 suggest that sound levels are expected to be below the SPL thresholds associated with either potential mortality or recoverable injury in fish of any hearing sensitivity for all of the vessel/receptor scenarios considered. Therefore, the likelihood of these potential impacts occurring is considered to be low.

The SEL thresholds for potential mortal injury in fish ranges from 207 to 219 dB re 1  $\mu\text{Pa}^2\cdot\text{sec}$ , and recoverable injury from 203 to 216 dB re 1  $\mu\text{Pa}^2\cdot\text{sec}$ . The maximum predicted cumulative SEL value (in either Priority Area 2 or 4) is 192.4 dB re 1  $\mu\text{Pa}^2\cdot\text{sec}$ . This indicates that sound levels are predicted to be below the SEL thresholds associated with either mortality or recoverable injury in fish of any hearing sensitivity for all of the vessel/receptor scenarios considered. Therefore the likelihood of these potential impacts occurring is considered to be low. The SEL TTS threshold for fish is 186dB dB re 1  $\mu\text{Pa}^2\cdot\text{sec}$  which is exceeded on a few occasions in Priority Area 2 (when the Geotiger vessels are in close proximity to each other in the late summer months) or in Priority Area 4 in October when sound propagation is highest.

However, fish are highly mobile and can easily move away from a sound source. Not only will there be a soft-start prior to operations commencing in water depths greater than 2m, but in addition all vessels are moving slowly and so local sound levels increase gradually and fish can easily move away. Thus, it is highly unlikely that fish will be subject to injurious levels of sound. There may be some behavioural disturbance, but this is expected to be of minimal magnitude because it will be very short term i.e. the fish will return to the area after the sound source has moved away. The temporary disturbance of individual fish is also not considered to have any likely impact on fish populations because any activities, such as foraging, that may have been interrupted will only be affected for a very short time period. There are no fish species at key life stages, such as spawning or breeding that may be more sensitive to disturbance, identified as being present in the 3D Seismic Survey Area during the survey.

### Seals

The results of the sound modelling, indicating the predicted distance at which sound level would be below the SPL or SEL thresholds for potential impacts to seals for each of the different vessels in Priority Areas 2 and 4 are shown in Tables 8.7 and 8.8. Detailed results of the modelling are presented in Appendix 8A.

**Table 8.7: Summary of Potential Impact Ranges for Caspian Seal Exposed to Seismic Sound for Priority Area 2**

Impact	Threshold value	Distance (m)		
		VSGA	Bubbles	Geotiger
<b>Sound Pressure Level - dB re 1 <math>\mu</math>Pa (peak unless stated otherwise)</b>				
Permanent Threshold Shift (PTS)	218	<1	1	9
Temporary Threshold Shift (TTS)	212	<1	6	32
Avoidance Behaviour	190 (rms)	<1	12 – 20	51 – 80
Limited Disturbance	150-180 (rms)	1 – 20	30 – 931	120 – 1932
<b>Sound Exposure Level - dB 1 <math>\mu</math>Pa<sup>2</sup>.sec</b>				
Permanent Threshold Shift (PTS)	186	< 1	100	300-405
Temporary Threshold Shift (TTS)	171	10	255-630	615-1455

**Table 8.8: Summary of Potential Impact Ranges for Caspian Seal Exposed to Seismic Sound for Priority Area 4**

Impact	Threshold value	Distance (m)		
		VSGA	Bubbles	Geotiger
<b>Sound Pressure Level - dB re 1 <math>\mu</math>Pa (peak unless stated otherwise)</b>				
Permanent Threshold Shift (PTS)	218	<1	1	9
Temporary Threshold Shift (TTS)	212	<1	6	32
Avoidance Behaviour	190 (rms)	<1	12 – 20	51 – 80
Limited Disturbance	180 -150 (rms)	1 – 20	30 – 2220	112 – 6640
<b>Sound Exposure Level - dB 1 <math>\mu</math>Pa<sup>2</sup>.sec</b>				
Permanent Threshold Shift (PTS)	186	< 1	100	405-550
Temporary Threshold Shift (TTS)	171	10	640-4250	1520-24440

The peak SPL results show that sound levels for a single seismic pulse in Priority Area 2 or Priority Area 4 decrease to below the PTS threshold within very close proximity to the individual source: <1 m in very shallow water (the VSGA in 0 to 2m); 1 m in water depths of 2 to 5m (Bubbles) and 9m for water depths >5m (Geotiger vessels).

In all months and for all Priority Areas the distances at which sound levels decrease to below any threshold level for the VSGA source array are very short because of the characteristics of the seismic source array (a small array and low source level) and the shallow water where sound is rapidly attenuated.

In Priority Area 2, sound level are predicted to decrease to below SPL thresholds values related to potential significant behavioural responses for a single pulse of sound from the Bubbles and Geotiger sources, within close proximity to the sound source. Avoidance behaviour may occur within 12-20m from Bubbles and between 51 and 80m from the Geotigers. Very limited disturbance is predicted to occur up to distances of between 30 and 2220m (depending on the month) in Priority Area 2 and between 112 and 6640m in Priority Area 4. The disturbance level is so low the impact on individuals is expected to be negligible. The distance ranges are due to the difference in sound propagation characteristics in the months, June to August, when the vessels will be present in Priority Area 2. For any seals that are present in Priority Area 2 during the survey behavioural responses to any of the individual vessels will be minimal.

PTS and TTS thresholds are also use the SEL metric, which refers to the sound energy accumulating over a period of time for a moving receptor. The results shown in Table 8.8 suggest PTS may occur if a seal is present within 100m of the Bubbles source or between 300 and 405m of a Geotiger source. TTS in Priority Area 2 may occur if a seal is present within 255 to 630m of the Bubbles source or within 615 to 1455m of a Geotiger source depending on the month (sound propagation increases from

June to August). These distances are estimated based on operation of the source array at full power i.e. not taking into account the soft start procedure so actual impacts are likely to be lower than predicted.

Whilst the modelling results suggest potential impacts may occur for a specific source/receptor scenario, it should be noted the actual likelihood of seal presence in Priority Area 2 during the survey is also very low due to careful survey scheduling. The survey in Priority Area 2 has been planned to take place in the summer months when most seals have migrated south to the mid Caspian Sea. Secondly, although a few seals may not migrate south, remaining to the north of the Absheron Peninsula, the survey has been scheduled to move from north to south to avoid them as far as possible.

The survey in Priority Area 4 is scheduled to take place in September (in the eastern sector) and October (in western sector) and therefore maximising the separation between the operation and potential presence of seals during October. Sound is expected to propagate further in October due to falling water temperatures and so predicted threshold distances are higher. The results shown in Table 8.8 suggest PTS may occur if a seal is present within 100m of the Bubbles source or between 405 and 550m of a Geotiger source. TTS in Priority Area 4 may occur if a seal is present within 640 to 4250 m from the Bubbles source or within 1520 to 24,440m from a Geotiger source depending on the month (sound propagation increases from September to October). These distances are estimated based on operation of the source array at full power i.e. not taking into account the soft start procedure so actual impacts are likely to be lower than predicted.

In Priority Area 4 sound level are predicted to decrease to below SPL threshold values related to significant behavioural responses to the sound produced by Bubbles and Geotigers but that this will also be limited to distances very close to the sound source. Avoidance behaviour may occur within 12 to 20m from Bubbles and between 51 and 80m from the Geotigers. The ranges refer to the difference in sound propagation levels in the months September to October, when the vessels will be present in Priority Area 4. For any seals that are present in Priority Area 4 during the survey behavioural responses to any of the individual vessels will be minimal.

However, the likelihood of seal presence in Priority Area 4 during the survey is also very low due to careful scheduling. The survey in PA4 is scheduled to start in September, and is scheduled to cover the sensitive areas before the migration season starts by moving from east to west. Therefore, as the survey moves into October, when sound propagation is predicted to be greatest, the survey vessels are expected to be west of the seals. Also, in contrast to the spring migration, the autumn migration (beginning in October and peaking in November (Section 5.5.6.3 of Chapter 5)) is not characterised by large groups of seals using the islands of the Absheron archipelago and so even at the most sensitive period the number of seals is expected to be low.

The multiple vessel sound modelling analysis looked at a number of different generic vessel start locations, directions of travel and cross-line (Y-axis) separation distances between the Bubbles and the two Geotiger vessels. Previous experience on similar seismic projects has shown, for operational and safety reasons, the realistic minimum distance between vessels may be approximately 1000m but that separation distances of 5000 to 8000m or more would be typical across the survey duration. Table 8.9 presents the scenarios considered (illustrated within Figures 8.1 and 8.2) and the modelling results obtained.

**Table 8.9: Maximum SPLS and SELs for Caspian Seals Exposed to Multiple Sources**

Scenario Description	Thresho Id metric	Predicted SPL/SEL ranges	
		Seals	
		P2 <sup>1</sup>	P4 <sup>2</sup>
<b>MS2.</b> Bubbles to Geotiger 2 – ~1000 m Bubbles to Geotiger 4 - ~2000 m Geotiger 2 to Geotiger 4 – 1000 m separation and 2000m offset	SPL	166.9-176.1	178.5-176.5
	SEL	173.1-185.5	<b>186.5-191.8</b>
<b>MS3.</b> Bubbles to Geotiger 2 – ~1500 m Bubbles to Geotiger 4 - ~2200 m Geotiger 2 to Geotiger 4 – 2000 m separation and 2000m offset	SPL	159.4-173.2	173.0-176.4
	SEL	165.9-183.5	183.6- <b>191.7</b>
<b>MS6.</b> Bubbles to Geotiger 2 – ~2000 m Bubbles to Geotiger 4 - ~3200 m Geotiger 2 to Geotiger 4 – 5000 m separation and 2000m offset	SPL	156.3-167.5	167.8-173.4
	SEL	159.7-177.3	177.8- <b>190.5</b>
<b>MS7.</b> Bubbles to Geotiger 2 – ~4000 m Bubbles to Geotiger 4 - ~4500 m Geotiger 2 to Geotiger 4 – 8000 m separation and 2000m offset	SPL	156.2-166.2	166.2-172.4
	SEL	159.3-174.0	174.7- <b>190.4</b>
<b>MS9.</b> Bubbles to Geotiger 2 – 6000 m Bubbles to Geotiger 4 - ~6300 m Geotiger 2 to Geotiger 4 – 12000 m separation and 2000m offset	SPL	156.2-165.7	165.8-171.0
	SEL	159.3-172.9	173.3- <b>189.2</b>

For two VSGA vessels working in very shallow water (0 to 2m depth) the sound modelling results suggest that sound levels are not likely to be above the SEL threshold levels associated with either potential PTS or TTS in either Priority Area 2 or Priority Area 4. Similarly sound levels are not likely to be above the SEL threshold level associated with either potential PTS or TTS when considering a VSGA in combination with the Bubbles vessel in 2-5m water depth. Thus, VSGA vessels were not considered further in the multiple vessel analysis.

As presented in Table 8.9, maximum cumulative SELs in Priority Area 4 are predicted to be above threshold levels for PTS for all months (September and October) with the smallest separation between vessels (MS2), however during October the PTS level is exceed for all separation scenarios. As with all the modelling these predictions are based on operation of the source array at full power i.e. not taking into account the soft start procedure and Mitigation Buffer Zone. Furthermore, it should be noted that within Priority Area 4 the survey will commence in the east and move west to avoid peak sensitivity of migrating seals.

Maximum cumulative SELs in Priority Area 2 are predicted to be below threshold levels for PTS for all months (June to August) (Table 8.9).

It should be noted however that in addition to the temporal/spatial avoidance measures being implemented via scheduling of survey activities the likelihood of Caspian seals being present in the survey area at the same time as the vessel operation, impacts are anticipated to be further reduced based on the following information:

- The autumn seal migration route from the Southern Caspian passes to the east of Shahdili Spit towards the Northern Caspian with autumn migration generally beginning in October and peaking in November (Section 5.5.6.3 of Chapter 5). It should be noted that in recent years it has been reported that the migration period has been observed to be delayed into December.
- No observations of seals have been reported to the west of the Shahdili Spit at any time of year. It is understood that seals generally avoid the shallow coastal waters south of the Absheron Peninsula due to high turbidity in the area generated by currents, the relatively shallow water and high levels of disturbance from the military base located on the coastline of the west of Priority Area 4 which includes frequent flyovers by helicopters. As such in October the survey is anticipated to be within an area of Priority Area 4 not used by seals.

Therefore it is considered highly unlikely that seals would be present within the area being surveyed in Priority Area 4 during October and would not be exposed to the levels of sound suggested by the modelling results.

### 8.3.2.3 Magnitude of Impact

Taking into account the results of the underwater sound modelling, the existing controls described above and the impact significance criteria set out in Chapter 3 of the ESIA, the event magnitude associated with the operation of survey sound source is presented within Table 8.10 and Table 8.11 below.

**Table 8.10: Event Magnitude (Fish)**

Parameter	Explanation	Rating
Extent / Scale	The onset of permanent or recoverable injury in all fish hearing groups may occur at very small distances (10s of metres) from the energy source in single and multiple vessel scenarios Some behavioural responses may occur but these are only a short range and will be of short duration only.	1
Frequency	Underwater sound emissions occur repeatedly but intermittently.	2
Duration	Sound energy dissipates with distance from the source and the sound source is moving, therefore a given sound level in any one location will last for a very short period of time, with the resulting potential impact lasting probably in the order of one or a few hours.	1
Intensity	The onset of permanent or recoverable injury would be a high intensity event. However the combination of a moving sound source and existing controls such as a soft-start procedure suggests fish will move away from the energy source. As such the impact from underwater sound, taking into account existing controls, is anticipated to be of low intensity.	1
<b>Total</b>		<b>5</b>

**Table 8.11: Event Magnitude (Caspian Seals)**

Parameter	Explanation	Rating
Extent / Scale	Sound modelling indicates that injury in seals may occur only at close range to the sound source but TTS may occur at greater distances from the source. However, the survey has been carefully scheduled such that during this period vessels will be operating in an area where seal presence is considered very unlikely and so the scale of the event is considered small.	1
Frequency	Underwater sound emissions occur repeatedly but intermittently.	2
Duration	Sound will last for a very short period of time, with the resulting impact lasting probably in the order of one or a few hours.	1
Intensity	The onset of permanent auditory shift (defined as PTS) would be a high intensity event however there is considerable uncertainty whether PTS would occur. The modelling predicts PTS impacts may occur at only close proximity to the vessel but existing controls such as a soft-start, reduce this potential intensity to low. Some behavioural response may occur so this is regarded as a medium intensity event.	2
<b>Total</b>		<b>6</b>

### 8.3.3 Receptor Sensitivity

#### Fish

Fish known to be present within the 3D Seismic Survey Area include a number of endangered species and species with moderate or high sensitivity to underwater sound. The species present (including seasonal activity, hearing sensitivity, depth of occurrence and protection status) are summarised within Table 5.21 of Chapter 5.

With regard to endangered species, a number of sturgeon species are known to migrate through the 3D Seismic Survey Area in March and April and again in September to November. Thus, there may be some individuals present in the survey area in November. However, these fish are not common and do not use the area in which the survey takes place exclusively as they are only passing through on their passage from spawning grounds in freshwater rivers of the south and southwest and feeding grounds in the north. Also, in November sturgeon are more likely to be found away from the coast in deeper water (refer to Chapter 5 Section 5.5.6.2). Sturgeon species also have medium or moderate hearing sensitivity as although they have a swim bladder it is not specifically used in hearing.

Fish species likely to be present in the 3D Seismic Survey Area that are highly sensitive to underwater sound include shad (the genus *Alosa*) and kilka (the genus *Clupeonella*). These species have structures that mechanically couple the inner ear to the swim bladder increasing the hearing ability compared to other fish. Shad and kilka will be migrating along the coastline during the 3D Seismic Survey Area, shad in spring and autumn and kilka in spring, summer and winter. However, they are passing through are only likely to be in the vicinity of any one of the survey vessels for a very short time, probably only hours. They are also highly mobile and able to avoid any underwater sound and SELs that could be injurious to fish are not anticipated.

There may be resident fish, such as gobies, spawning within the 3D Seismic Survey Area probably in the spring and summer. In some species, such as the round goby *Neogobius melanostomus*, the male will stay with and defend the eggs so may not move away from an approaching sound source. However, gobies are common and widely distributed so any impacts are likely to be very localised and short term.

With regard to the current status of fish populations, as summarised within Chapter 5 Section 5.5.6.2, catch size of the most important commercial fish (kilka) has significantly reduced over the years with a reduction of 96% recorded between 2002 and 2011. This is due in part to overfishing but also to the presence of the invasive ctenophore (*Mnemiopsis leidyi*) which is known to predate on fish eggs and larvae and zooplankton. Fish populations are therefore considered to be reasonably vulnerable.

Existing controls associated with the survey include use of a soft start procedure at the start of each survey line, where the sound is ramped up gradually over a period of time. Local sound levels will also increase and decrease slowly as the vessels are moving. This allows any individual fish in the vicinity of the sound source to move away before sound levels become injurious. Thus, there is very low injury risk to individual fish and fish populations are unlikely to be affected. Behavioural responses are highly unlikely to result in any detectable population size changes because the magnitude of the response in most individuals will be small and sensitive life stages (e.g. spawning) are not present. Also changes in swimming direction are a natural behaviour during migration periods as fish respond to prey and predator abundance and changes in underwater topography. Receptor Sensitivity is shown in Table 8.12 below.

**Table 8.12: Receptor Sensitivity (Fish)**

Parameter	Explanation	Rating
Resilience	Endangered fish species and hearing specialist fish are likely to be present for limited periods of time in the 3D Seismic Survey Area. However, these species are widely distributed and do not use the Seismic Survey Area exclusively. Also, there will be no fish species at the sensitive spawning stage likely to be present. Individual fish are at very low risk of injury or significant behavioural disturbance and therefore the risk to populations is considered to be even lower.	1
Presence	Fish species are able to easily move away from underwater sound before permanent or temporary injury impacts are likely to occur. There may be a change in behaviour but this is expected to be limited to a change in swimming direction and is expected to be short-term. Ecological functionality will be maintained and no impact on populations predicted.	1
<b>Total</b>		<b>2</b>

## Seals

The endemic Caspian seal, *Phoca caspica*, a threatened species with an IUCN Red List ‘Endangered’ status and AzRDB listed, will be present in some of the 3D Seismic Survey Area during the spring and autumn migration periods. Seals are most likely to be seen to the east of the Shahdili Spit in Priority 4 and to the east of the Absheron Peninsula and in the vicinity of the islands between Pirallahi and Chilov islands in Priority Area 2 from April to May and October to mid-December. The months when the highest numbers of seals are likely to be present are April, May and November. The survey has been scheduled to avoid these most sensitive times with Priority Area 2 surveyed between June and September (moving north to south) and Priority Area 4 from September to October (moving east to west). Current information available on seal migration timing and routes are described within Chapter 5, Section 5.5.6.3, which distinguishes different levels of sensitivity within Priority Areas 2 and 4 with seals sightings exclusively in areas to the east of the Shahdili Spit. While as described within Section 8.3.2.2 above it is considered highly unlikely seals would be present within the area being surveyed in Priority Area 4 during October (which is to the west of Shahdili Spit), it has been established that some spring migrating individuals do not head further south, remaining in waters to the east and north of the Absheron Peninsula during the summer months. There is therefore, the potential for very low numbers of seals to be present in Priority Area 2 when the 3D Seismic Survey is in progress.

As stated within Chapter 5 Section 5.5.6.3 the Caspian seal population has significantly declined over the 20th Century (by more than 90% since the start of the century) and continues to decline due to a combination of factors including commercial hunting, habitat degradation (through introduction of invasive species), disease, industrial development, pollution and fishing operations. The seal population is therefore highly vulnerable as reflected by its “Endangered” status.

The Caspian seal is a highly intelligent animal and will rapidly move away from any disturbance or sound. They are also air breathing mammals and whilst they may be subject to underwater sound during feeding they return to the surface on a regular basis, and may remain on the surface, holding their head out of the water, to avoid exposure to underwater seismic sound.

Receptor Sensitivity is summarised within Table 8.13 below.

**Table 8.13: Receptor Sensitivity (Seals)**

Parameter	Explanation	Rating
Resilience	Internationally protected Caspian seals may be present in some of the 3D Seismic Survey Area during spring and autumn migrations. However, the seals are passing through on migration routes and will be present for a short time only. The survey period does not overlap with the most sensitive periods in the seals’ lifecycle i.e. breeding (which occurs in the Northern Caspian) and spring migration when seals are travelling south to replenish depleted fat reserves following breeding and pupping.	2
Presence	Seals are known to be present within areas of Priority Areas 2 and 4 during autumn migration (periods of high sensitivity) but in much lower numbers than is observed in the spring. The survey has been scheduled such that activity within Priority Areas 2 and 4 during spring and autumn migration has been minimised.	2
<b>Total</b>		<b>4</b>

### 8.3.4 Impact Significance

Table 8.14 summarises impacts to fish and seals associated with operation of the energy source.

**Table 8.14: Impact Significance**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Underwater sound from energy source	Medium	Low (Fish)	Minor Negative
		Medium (Seals)	Moderate Negative

The following monitoring and reporting activities will be undertaken related to seals:

- In addition to the monitoring and recording Caspian seals as part of the soft start procedure, the trained vessel crew will endeavour to record Caspian seal sightings at other times as far as practically possible;
- Daily logs of Caspian Seal sightings will be completed by the trained vessel crew using the relevant JNCC marine mammal forms<sup>17</sup>; and
- A final report summarising the Caspian seal observations over the duration of the survey and including all the daily log forms will be completed by the trained vessel crew and submitted to BP within eight weeks of completion of the survey.

## **8.4 Impacts to the Terrestrial Environment (Birds and Protected Areas) Due to Offshore Survey Activities**

In air sound and disturbance associated with the offshore survey activities, as described in Section 4.5.1 of Chapter 4, has the potential to impact to birds and Protected Areas (including Important Bird Areas (IBAs) and the Absheron National Park) within and immediately adjacent to the 3D Seismic Survey Area.

### **8.4.1 Mitigation**

To minimise potential impacts from the offshore survey activities to birds and Protected Areas a number of control measures have been included in the project design. These include the following:

- It is not planned to undertake any survey activities within the boundary of the Absheron National Park;
- The survey will be undertaken in accordance with the agreed project schedule (refer to Chapter 4 Figure 4.1); where feasible it has been designed to take into account of the presence and seasonal sensitivity of protected species and protected areas;
- The survey within Priority Area 2 will commence in the north of the Priority Area and move south, within Priority Area 4 the survey will commence in the east and move west and within Priority Area 1 survey activities within the vicinity of Tava and Boyuk Zira islands will be completed within March;
- In the event that it is not possible to avoid the nesting season (April to July), a local ornithologist will accompany the survey crew. Offshore, should any nesting birds be observed then the survey vessel will approach slowly whilst the ornithologist observes the behaviour of the breeding birds. The ornithologist will advise the survey vessel crew of the level of disturbance which is allowable which may be dependent upon weather and the state of nesting. Onshore, an ornithologist will scout the area prior to the laying of nodes and should any nesting birds be observed the ornithologists will advise the survey crew of the level of disturbance which is allowable;
- In the event of a delay of more than 7 days, the schedule will be reconfirmed, taking into account safety, technical, operational and ecological seasonal considerations and additional mitigation adopted as required before proceeding. This may include the use of additional buffer zones or adaptation of survey methods;
- All offshore survey activities within water depths of 5m or less will take place during daylight hours only;
- The offshore survey will be undertaken using suitably experienced and qualified vessel operators; and
- Offshore survey personnel will be provided with environmental awareness training that includes measures designed to minimise sound and disturbance generated by offshore survey activities.

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<sup>17</sup> Joint Nature Conservation Committee (JNCC), 2010. JNCC guidelines for minimising the risk of injury and disturbance to marine mammals from seismic surveys, Aberdeen.

## 8.4.2 Event Magnitude

Offshore survey activities include movements of source, node and supply vessels across the 3D Seismic Survey Area, operation of energy sources and deployment and retrieval of nodes as described within Chapter 4 Section 4.5.1.

As described within Chapter 4 the 3D Seismic Survey Area has been subdivided into 5 Priority Areas with each Priority Area further subdivided into zones based on water depths; 0 to 2m, 2 to 5m and greater than 5m as defined by the survey techniques and vessels to be used in these zones. The survey schedule, which has been informed by seasonal sensitivities as described within Section 8.3.3 above (fish and seals) and Section 8.4.3.1 below (birds), is illustrated within Chapter 4 Table 4.1. It is intended that:

- Survey activities within Priority Area 2 (between June and September 2016) will commence in the north and move south; and
- Survey activities within Priority Area 4 (between September and October 2016) will commence in the east and move west.

Protected Areas within or adjacent to the 3D Seismic Survey Area (as shown within Chapter 5 Figure 5.9) include:

- Absheron archipelago (north) and Pirallahi Bay IBA – this IBA includes Pirallahi and Chilov islands (both inhabited and subject to anthropogenic activity) as well as numerous smaller islands to the east of the Absheron Peninsula. The islands that comprise the IBA cover a total area of approximately 5500 hectares. Approximately 35% of this area is located within Priority Area 2;
- Shahdili Spit IBA and Absheron National Park – the Shahdili Spit is designated both as an IBA and National Park (IUCN Category II<sup>18</sup>). The area of the National Park and IBA is approximately 800 hectares. The National Park is surrounded by a buffer zone which extends approximately 3km offshore and 2km onshore. While no activities are planned within the Shahdili Spit onshore area i.e. within the National Park, offshore activities are planned within Priority Area 4 which surrounds the Spit; and
- Sahil Settlement IBA - comprises an area of coastal lagoons and an offshore area up to 10m water depth and is located within Priority Area 5.

In addition, while not Protected Areas, the following areas are also of importance for birds (refer to Section 5.4.6.4 of Chapter 5):

- Areas of approximately 2-3km<sup>2</sup> in the vicinity of Turkan and Hovsan used during overwintering (located in Priority Area 3); and
- Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar islands used by nesting birds. The majority of these islands are located between Priority Area 1 and 3 with the exception of Tava and Boyuk Zira islands which are located in Priority Area 1.

Based on the survey schedule and planned survey activities as described within Chapter 4 the anticipated activities within or adjacent to the Protected Areas are summarised within Table 8.15 below.

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<sup>18</sup> The main objective of a national park (IUCN Category II) is to protect functioning ecosystems, rather than focussing on protecting a particular species or habitats through management of the reserves thus prioritising these species or habitats which would come under IUCN category IV

**Table 8.15: Offshore Seismic Survey Activities Proposed Within or Adjacent to Protected Areas**

PA	Protected Area	Description of Survey Activities	Period Over Which Survey Activities Are Planned
2	Absheron archipelago (north) and Pirallahi Bay Important Bird Area (IBA)	<p><b>Vessel movements and operation of seismic sources:</b> All three offshore survey techniques will be used within this Priority Area with extensive use of the vessels suitable to operate in water depths of less than 5m within the centre of the Priority Area where shallow water depths occur, particularly around the islands present that comprise the IBA (refer to Chapter 4 Figure 4.2). It is planned that the survey will commence in the north of the Priority Area where water depths are greater than 5m and move south. It is not planned to reach the shallower water depths earlier than the end of July.</p> <ul style="list-style-type: none"> <li>• <b>Node deployment:</b> nodes will be deployed from vessels on the seabed as described within Chapter 4 Section 4.5.1.5 as the survey progresses. As the survey reaches the islands towards the centre of the Priority Area it is also planned to use a crew to deploy the autonomous nodes used for the onshore survey on the islands using the same grid spacing as adopted for the onshore survey i.e. The nodes will be recovered following use and data to be downloaded either offshore on the survey vessels or at the base or sub base.</li> </ul>	<p>Mid June to start of September</p> <p>Activities within and immediately adjacent to the IBA due to occur between end of July to the start of September and last for days to weeks at a time.</p>
4	Shahdili Spit IBA and Absheron National Park	<ul style="list-style-type: none"> <li>• <b>Vessel movements and operation of seismic sources:</b> Across the majority of Priority Area 4, water depths are greater than 5m, however water depths around the Shahdili Spit are very shallow. It is planned that the survey will commence in the east and move west.</li> <li>• <b>Node deployment:</b> nodes will be deployed from vessels on the seabed as described within Chapter 4 Section 4.5.1.5 as the survey progresses. It is planned the nodes will be deployed as close as possible to the shoreline of the Shahdili Spit using the smallest node vessel (refer to Chapter 4 Section 4.5.1).</li> </ul> <p>It is anticipated that activities within the National Park offshore buffer zone will last up to 4 weeks in total.</p>	<p>September and October</p> <p>Activities adjacent to the boundary of National Park/ IBA due to occur during September and October for days at a time.</p>
5	Sahil Settlement IBA	<ul style="list-style-type: none"> <li>• <b>Vessel movements and operation of seismic sources:</b> Across the majority of Priority Area 5, water depths are greater than 5m with water depths in the vicinity of the IBA generally between 2 and 5m including within the deep lagoons which are included within the IBA. As such the Bubbles source vessel will be primarily used in the vicinity of the IBA, supported by node vessels and support vessels designed for this water depth, with the VSGA source vessel used where required.</li> <li>• <b>Node deployment:</b> nodes will be deployed from vessels on the seabed as described within Chapter 4 Section 4.5.1.5 as the survey progresses. Nodes will not be deployed onshore. The nodes will be recovered following use and data to be downloaded either offshore on the survey vessels or at the base or sub base.</li> </ul>	<p>November</p> <p>Activities within and immediately adjacent to vicinity of the IBA due to occur through November for days at a time.</p>

In addition to the activities described in Table 8.15, with regard to Priority Area 3, survey activities are planned to occur between April and June outside the overwintering period for birds. In Priority Area 1 the survey is planned to be completed within the vicinity of Tava and Boyuk Zira islands within March, prior to the nesting season. However, in the event that it is not possible to avoid the nesting bird season (April to July), a local ornithologist will accompany the survey crew as described in Section 8.4.1.

As shown in Table 8.15 the project activities within or adjacent to each Protected Area will occur over days to weeks at a time. These offshore activities have the potential to give rise to disturbance, from the operation of vessels, the energy source and movement of people on the vessels. Due to the water depths within the vicinity of the protected areas it is anticipated that the smaller source and node survey vessels will be used for these activities (suitable for use in water depths less than 5m). Each of these vessels has a crew of four or less. A thorough review of studies aimed at assessing behaviour of overwintering, migrating and nesting waterfowl to various types of human disturbance including vessel sound has shown that typically birds will not take flight until a disturbance such as from a vessel is closer than 30-50m although they may be aware of distances at distances of 200-300m<sup>19</sup>.

As described above the crews will undergo environmental awareness training to ensure sound and disturbance from the survey activities are minimised in the vicinity of protected areas through good practice (e.g. prohibited use of horns except for safety reasons).

Table 8.16 presents that justification for assigning a score of 7 to sound and disturbance associated with the offshore survey activities affecting birds and protected areas which represents a medium event magnitude.

**Table 8.16: Event Magnitude**

Parameter	Explanation	Rating
Extent / Scale	Sound and disturbance to birds and protected areas is expected to occur within the range tens to hundreds of metres.	1
Frequency	Disturbance will be repeated but intermittent.	2
Duration	Vessels will be present within the vicinity of protected areas and other areas important to birds for periods of days to weeks.	2
Intensity	Taking into account the survey schedule and the period of time the vessels are in the vicinity of the protected areas and other areas known to be used by birds (days to weeks) and the localised disturbance due to the vessel activity, the event intensity is considered to be moderate.	2
<b>Total</b>		<b>7</b>

The figure shows a horizontal scale from 1 to 12. The scale is color-coded: 1-3 are yellow, 4-6 are orange, 7 is red, 8-12 are dark red. A circle is drawn around the number 7.

### 8.4.3 Receptor Sensitivity

#### 8.4.3.1 Overwintering, Migrating and Nesting Birds

As described within Chapter 5 Section 5.4.6.4 a large number of overwintering, migrating or nesting birds will be present throughout the year in the three IBAs which are located within or adjacent to Priority Areas 2, 4 and 5. Figure 5.8 within Chapter 5 presents the key periods of seasonal sensitivity.

As discussed within Chapter 5 there are a number of areas within each IBA that are considered particularly vulnerable at key times of the year:

<sup>19</sup> 2012, Kathi L. Borgmann, A Review of Human Disturbance Impacts on Waterbirds  
December 2015  
Draft

Absheron Archipelago (north) and Pirallahi Bay IBA:

- **Overwintering (December-February):** The key area of importance during the overwintering period is Pirallahi island, where a number of species (tufted duck, common pochard, and great crested grebe) have been recorded in numbers exceeding the indicator set for the provision of RAMSAR status;
- **Autumn migration (late August to start of December):** The most significant period during the autumn migration is November when birds who will stay and overwinter and those that will continue south are present across all the islands within the IBA;
- **Nesting season (mid/late April – mid/end July):** During the nesting period, birds predominantly use the following areas (refer to Appendix 5B):
  - Suitable habitat located on the south west of Pirallahi island with the species present using this area between April and early July;
  - Yal island, near to Chilov island, and adjacent abandoned oil rigs between April and July where four species have been observed nesting (great cormorant, Caspian gull, common tern and little tern);
  - Boyuk Tava and Kichik Tava Koltis islands, which lie between Pirallahi and Chilov island, where two species (Caspian gull and common tern) have been observed nesting on platforms between April and July; and
  - Garabatdag island between Chilov island and the Shahdili Spit, where one species has been recorded nesting between April and July on sand (common tern) and two (great cormorant and Caspian gull) on abandoned oil rigs.

Other locations within the IBA were assessed as being unsuitable for nesting birds due to lack of habitat or level of existing disturbance. One nesting species of conservation importance (purple heron Azerbaijan Red Data Book<sup>20</sup> (AzRDB)) has been recorded in this area.

- **Spring migration (mid April to late July):** The IBA is not recognised as being of high importance during the spring migration except for birds that use the area for nesting as described above.

Shahdili Spit IBA:

- **Overwintering (December-February):** a significant number and variety of coastal and waterfowl species overwinter on the Shahdili Spit with numbers of tufted duck and common pochard recorded in numbers exceeding the indicator set for the provision of RAMSAR status. In addition a number of AzRDB listed species have been recorded including greater flamingo, great white pelican, dalmatian pelican, mute swan and the purple swamphen which is present year round. A number of birds listed within the IUCN Red List of Threatened Species<sup>21</sup> may also occasionally be present (refer to Chapter 5 Table 5.7);
- **Autumn migration (late August to start of December):** The most significant period during the autumn migration is November when birds who will stay and overwinter and those that will continue south are present across the IBA;
- **Nesting season (mid/late April – mid/end July):** The Shahdili Spit is used by a wide variety of species for nesting (primarily terns and gulls but also wading birds including plover and avocet, herons, grebes and coots), making use of various habitats across the area including sandy areas, reeds and marsh. One nesting species of conservation importance (pied avocet AzRDB listed) has been recorded in this area.
- **Spring migration (mid April to late July):** The Shahdili Spit is used by migrating birds throughout the spring migration period. The majority of these comprise ducks, gulls and coots, flying north for the summer.

<sup>20</sup> MENR, Azerbaijan Red Data Book (2015). Available at: <http://www.redbook.az/> Accessed December 2015

<sup>21</sup> IUCN, 2015, IUCN Red List of Threatened Species. Available at: <http://www.iucnredlist.org/> Accessed August 2015

Sahil Settlement IBA:

- **Overwintering (December-February):** Waterfowl that overwinter in Puta Bay and the associated lagoons typically include red-crested pochard, tufted duck and Eurasian coot. In addition a number of individuals of conservation importance have been occasionally observed using the area (refer to Chapter 5 Table 5.7). Total numbers of the species mentioned above have been recorded as exceeding the indicator set for the provision of RAMSAR status;
- **Autumn migration (late August to start of December):** Birds present in Puta Bay and the associated lagoons during the autumn migration period include a number of species (mainly ducks, seagulls and coots) that subsequently overwinter in the same location in addition to numerous other species of coastal bird and waterfowl. Birds numbers are at their peak during November (up to 100,000 or more birds).
- **Nesting season (mid/late April – mid/end July):** 0.1% of all coastal species along the Caspian coastline use the onshore areas within Puta Bay and between the associated lagoons during the nesting season. Species include seagulls, sandwich tern, common tern and Caspian gull.  
**Spring migration (mid April to late July):** As for the nesting season while Puta Bay and the associated lagoons are used by birds during the spring migration period, the numbers are less than during autumn and winter.

Other important areas for birds near to Turkan and Hovsan (overwintering birds) and Tava and Boyuk Zira islands south of Baku Bay (nesting birds) are outlined in Section 8.4.2 above.

The most sensitive time of year for birds is during nesting season when they are brooding eggs and are therefore least mobile. The characteristics and the surrounding areas vary for each IBA with the Shahdili Spit generally experiencing the least disturbance (except for the passage of helicopters associated with the nearby military base) and the greatest disturbance associated with the Absheron Archipelago (north) and Pirallahi Bay IBA associated with significant levels of passing vessels and human activity (on Pirallahi and Chilov islands in particular). Sahil Settlement IBA is undisturbed to the south but a port facility is located in the north of the IBA associated with the Deep Water Jacket Factory and the BP Logistics Base. Birds within the Absheron Archipelago (north) and Pirallahi Bay IBA and in the north of the Sahil Settlement IBA would therefore have a certain level of habituation to man-made sound and disturbance.

The existing controls provided within Section 8.4.1 above describe the measures to be adopted to minimise impacts to protected areas including the adoption of a survey schedule taking into account the seasonal sensitivities. In the event that it is not possible to avoid the nesting season (April to July), a local ornithologist will accompany the survey crew as described in Section 8.4.1. Activities within the vicinity of the Shahdili Spit IBA are planned to occur during September and October outside of migrating, overwintering and nesting bird seasons.

Activities within the Sahil Settlement IBA are anticipated to occur during November which is during the peak autumn migration period, however the activities will be undertaken in specific localised areas each day allowing the birds to move away from the disturbance e.g. to an alternative but nearby lagoon within the IBA.

Taking into account the existing controls described above and the impact significance criteria set out in Chapter 3 of the ESIA, the receptor sensitivity associated with overwintering and migrating birds and nesting birds due to offshore survey activities are presented within Table 8.17 and Table 8.18, respectively.

**Table 8.17: Receptor Sensitivity (Overwintering and Migrating Birds)**

Parameter	Explanation	Rating
Resilience	Overwintering and specifically migratory birds are highly mobile and have the capacity to move away from localised disturbance. As the survey would only be present in any one area for a short period any effects would be very short term and temporary and the birds would return to the area once the survey has moved and would be largely unaffected.	1
Presence	Overwintering and migratory birds will be present along the Absheron Peninsula specifically within the IBAs and the areas near to coastline at Hovsan and Turkan during December to February (overwintering) and late August to start of December (migratory). The peak period for migrating birds is November. Survey activities are not planned adjacent to areas of importance to birds during the overwintering period or during the peak migratory period except within Priority Area 5. In this area migrating birds will be present in the Sahil Settlement IBA during the period where peak numbers are present.	3
<b>Total</b>		<b>4</b>

**Table 8.18: Receptor Sensitivity (Nesting Birds)**

Parameter	Explanation	Rating
Resilience	Nesting birds specifically those brooding eggs are highly sensitive and have some but limited capacity to adapt to disturbance. In general if disturbed they would usually fly away and then return to their nests but not in all instances.	3
Presence	There are areas within each Priority Area (except Priority Area 3) known to be of importance for nesting birds. These include <ul style="list-style-type: none"> <li>• Gum Zira, Dash Zira, Boyuk Zira, Tava and Khanlar islands (within and adjacent to Priority Area 1)</li> <li>• Boyuk Tava, Kichik Tava, Koltis, Urinos, Yal and Garabatdag islands (Priority Area 2)</li> <li>• Shahdili Spit IBA (Priority Area 4)</li> <li>• Puta Bay and the associated lagoons (Priority Area 5)</li> </ul> The survey schedule has been designed to take into consideration the seasonal sensitivities of nesting birds. However, in the event that it is not possible to avoid the nesting season (April to July), a local ornithologist will accompany the survey crew as described in Section 8.4.1.	1
<b>Total</b>		<b>4</b>

**8.4.3.2 Absheron National Park**

The Absheron National Park area overlaps with the Shahdili Spit IBA. In addition to the importance of the area for birds, the National Park designation also reflects the presence of a variety of flora and fauna. Reptiles and amphibians reported to be present within the Park include green toad, common toad, marsh frog, lake frog, spur-thighed tortoise, Caspian tortoise, gecko, lizard, blunt-nosed viper and water snake<sup>22</sup>. Mammals reported to be present include bobcat, common hare, wild rabbit, wolf, jackal, fox, racoon, badger and a variety of rodents including crested porcupines. Within the last two years gazelle have been reintroduced to the park and the population has been observed to be increasing. The shores of the Park are recognised as an area used by Caspian seals for haul out during spring and autumn migration (April-May and November) (refer to Chapter 5 Section 5.5.6.3).

As stated in Section 8.4.2 seismic survey activities are not proposed within the Park itself and as such it is expected that there is very little potential for disturbance to the flora and fauna (reptiles,

<sup>22</sup> MENR Letter, 3 July 2015. Response to a Request for Information from BP. Ref. 4/1009-6.  
December 2015  
Draft

amphibians and mammals) within the Park from the offshore survey activities. In addition the survey is proposed to be undertaken in the vicinity of the Shahdili Spit over an approximate 4 week duration during September and October thus avoiding the key seal migration periods when seals may use the shores of the Spit for haul out.

Table 8.19 presents the justification for assigning a score of 4 to the Absheron National Park, which represents medium receptor sensitivity.

**Table 8.19: Receptor Sensitivity (Absheron National Park)**

Parameter	Explanation	Rating
Resilience	Survey activities will not be undertaken within the Absheron National Park. Sound and disturbance from the offshore survey activities is expected to be barely discernible or indiscernible to fauna (mammals, reptiles and amphibians) within the Park that will consequently be marginally affected or unaffected. The survey will have no effect on flora within the Park.	1
Presence	The Absheron National Park is nationally protected area categorised as IUCN Category II. Numerous nationally protected species listed within the AzRDB are known to be present in addition to a number of IUCN species including the Vulnerable Goitered gazelle and the Spur-thighed tortoise.	3
<b>Total</b>		<b>4</b>

#### 8.4.4 Impact Significance

Table 8.20 summarises impacts of offshore survey activities to birds and protected areas.

**Table 8.20: Impact Significance**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Offshore Survey Activities	Medium	Overwintering and Migrating Birds (Medium)	Moderate Negative
		Nesting Birds (Medium)	Moderate Negative
		Absheron National Park (Medium)	Moderate Negative

It is considered that potential impacts are minimised as far as practicable and necessary through the implementation of the existing mitigation measures and no additional controls are required.

### 8.5 Impacts to the Terrestrial Environment (In Air Sound) Due to Onshore Survey Activities

In air sound arising from the onshore survey activities, including vehicle movements and operation of the seismic source as described in Section 4.5.1 of Chapter 4 has the potential to impact human receptors.

#### 8.5.1 Mitigation

To minimise potential impacts from in air sound associated with the onshore survey activities a number of control measures have been included in the project design. These include the following:

- All onshore survey activities will take place during daylight hours only;
- Prior to the seismic survey commencing a programme of pre-planning surveys will be undertaken. These activities will inform the seismic survey design, including further informing the positioning of

survey lines and which of the proposed onshore methods are suitable for which areas (i.e. vibroseis or OnSeis);

- Safety distances between the seismic sources and existing infrastructure will be defined by the seismic contractor prior to the survey (during the mobilisation phase) in line with the current IAGC Minimum Offset Guidelines for Land Seismic Surveys<sup>23</sup>;
- Seismic lines will be offset to maintain safety distances from sensitive receptors calculated using relevant guidance and project specific parameters;
- A Communication and Consultation Management Plan will be implemented and maintained as a mechanism of communicating with the communities. As part of the plan Community Liaison Officers (CLOs) will arrange meetings with community leaders, farmers and property owners and will provide information to the local people about the seismic operations, relay information between the seismic crew and the public and address any grievances;
- A grievance procedure to enable public and stakeholder concerns to be addressed in effective and timely manner will be established and implemented;
- Onshore survey personnel will be provided with environmental awareness training that includes measures designed to minimise sound (e.g. minimise idling and revving of engines);
- Vehicles movements will be minimised as far as possible; and
- All survey vehicles and equipment will be modern and well maintained in accordance with written procedures based on the manufacturer's guidelines, applicable industry code, or engineering standards to ensure efficient and reliable operation.

### 8.5.2 Event Magnitude

As described within Chapter 4 Section 4.5.2 onshore seismic survey activities will include movement of source, node and support vehicles and operation of onshore seismic sources across the onshore 3D Seismic Survey Area. Three types of seismic sources (AHV-IV vibroseis truck, UNIVIB small scale vibroseis truck and OnSeis unit) will be available and will be used depending on terrain conditions and access. Across the majority of the onshore survey area, where access and ground conditions permit, it is anticipated that four vibroseis trucks will be used, operating in close proximity as a linear fleet. To estimate sound levels at increasing distance from the sound source, calculations based on the guidance provided within BS5228:2009<sup>24</sup> were undertaken<sup>25</sup>.

Reported sound pressure levels in air are available within BS5228:2009 for vibratory activities similar to use of vibroseis trucks along with vendor supplied sound pressure level data for the UNIVIB trucks. By comparing these sound levels it is considered that the sound level from all three source types will be similar and the vendor supplied noise level for the UNIVIB trucks is representative of sound levels associated with all three source types<sup>26</sup>.

The calculated sound levels were compared against the guidance daytime<sup>27</sup> sound level provided within BS5228:2009 of 70dB(A) for residential locations within "rural, suburban and urban areas away from main road traffic and industrial noise". The calculations indicated that at distances of 25m or more from the seismic source sound levels would be below 70dB(A). At distances of between 80m and 200m sound levels are expected to be between 50 and 60 dB(A) with sound levels below 50dB(A) at distances of 200m or more from the sound source.

Increases in sound levels due to operation of the engines of all the vehicles (including support vehicles) during the survey activities were also calculated using the methodology provided within BS5228:2009 and typical source sound levels for heavy and light goods vehicles (HGVs and LGVs)<sup>28</sup>. To give a conservative estimate it was assumed that all the survey and support vehicles listed within Chapter 4 Section 4.5.2.1 would be travelling together<sup>29</sup>. Source sound levels were based on the

<sup>23</sup> International Association of Geophysical Contractors, 2007, Minimum Offset Guidelines for Land Seismic Surveys

<sup>24</sup> British Standards Institute (BSi), (2009): 'BS5228 – Noise Vibration Control on Construction and Open Sites', BSi, London

<sup>25</sup> While the seismic survey is not a construction activity the BS5228 guidance is appropriate as it relates to temporary increases in sound including sound generated by vehicles and ground impact activities e.g. impact piling

<sup>26</sup> Quoted as 81 dB(A) at a reference distance of 7 metres to the side of the truck

<sup>27</sup> Defined as between 07.00 and 19.00 hours

<sup>28</sup> HGV: sound power level of 110 dB  $L_w$  and car/LGV: sound power level of 99 dB  $L_w$

<sup>29</sup> In reality support vehicles will be undertaking activities both ahead and behind main survey spread and at the main base and sub bases.

number and type of vehicles assuming 12 HGVs and 18 cars/LGVs. The calculations indicated at distances of 10m or more from the survey vehicles, sound levels would be below 61dB(A)<sup>30</sup>.

The sound generated from both vehicles movements and the source operation will be very short term and transient. The survey will be present in each survey location for minutes and will move on to the next location. In addition it is planned that residents present in the vicinity of the survey will be made aware of the survey activities, the planned schedule and the potential for sound prior to the survey commencing in accordance with the existing controls.

Table 8.21 presents the event magnitude associated with the sound due to operation of onshore survey sound source and use of the onshore survey vehicles.

**Table 8.21: Event Magnitude**

Parameter	Explanation	Rating
Extent / Scale	Noise levels are predicted to be less than the relevant guidance sound limit at distances of 25m or more from the sound source. Sound levels from the survey activities are expected to be similar to general background levels at 80m to 200m from the sound source.	1
Frequency	Sound from the onshore survey activities will occur repeatedly but intermittently. Sound due to the survey will only be experienced at any given receptor typically once or twice.	1
Duration	Sound dissipates with distance from the source and as the sound source is moving, a given sound level in any one location will last for a very short period of time, ceasing once the sound source has moved away from the receptor.	1
Intensity	Sound will be transient, non-persistent and localised. With the implementation of the existing control measures, disturbance is expected to be minimal.	1
<b>Total</b>		<b>4</b>

### 8.5.3 Receptor Sensitivity

As discussed within Chapter 5.4.5 existing sound levels across the onshore 3D Seismic Survey Area vary with background sound levels recorded during the survey undertaken in November 2015 between 45dB(A) (at an urban location within Yeni Turkan in Priority Area 3) to 72dB(A) (at a location in Priority Area 1 adjacent to the main Baku-Salyan Highway). During the survey period dominant sound sources were generally identified as road traffic with occasional sound from airplanes and helicopters and animals in rural locations. The background sound environment across the 3D Seismic Survey Area therefore varies from reasonably quiet (approximately equivalent to the WHO noise limit for nighttime<sup>31</sup>) to fairly loud (greater than the 70dB(A) guidance limit value). As such communities within the onshore 3D Seismic Survey area are generally habituated to sound similar in nature to that generated by the seismic survey activities.

<sup>30</sup> Based on a 1 hour averaging period

<sup>31</sup> World Health Organisation (1999), Guidelines for Community Noise

Table 8.22 presents the justification for assigning a score of 4 to human receptors, which represents medium receptor sensitivity.

**Table 8.22: Receptor Sensitivity (Human Receptors)**

Parameter	Explanation	Rating
Resilience	Modelling results have indicated that sound from the survey activities will meet applicable guidance sound limits at receptors at distances of more than 25m from the survey noise sources. Sound from the survey is likely to be of very short duration, resulting in a brief nuisance to nearby receptors who have the capacity to tolerate the short term sound increase and are habituated to brief increases in sound levels.	1
Presence	Residential receptors will be located in proximity to the survey activities.	3
<b>Total</b>		<b>4</b>

### 8.5.4 Impact Significance

Table 8.23 summarises impacts of in air sound associated with the onshore survey activities.

**Table 8.23: Impact Significance**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
In air sound arising from onshore survey activities, including vehicle movements and operation of the seismic source	Low	Human Receptors (Medium)	Minor Negative

The following monitoring and reporting related to sound from the onshore survey activities will be undertaken:

- A sound monitoring programme will be established prior to and during the onshore seismic survey as part of the Environmental and Cultural Heritage Management Plan with the aim of confirming sound levels prior to and during the survey. Representative sound monitoring shall be carried out periodically during the survey activities e.g. at the start of seismic survey activities near to residential areas in each Priority Area to confirm sound levels; and
- Results from the sound monitoring surveys will be provided to relevant key stakeholders as specified within the Communication and Consultation Management Plan.

It is considered that potential impacts are minimised as far as practicable and necessary through the implementation of the existing mitigation measures and no additional controls are required.

## 8.6 Impacts to the Terrestrial Environment (Groundborne Vibration) Due to Onshore Survey Activities

Groundborne vibration arising from the operation of the seismic source as described in Section 4.5.1 of Chapter 4 has the potential to impact physical structures and human receptors.

### 8.6.1 Mitigation

Control measures to minimise the impact of vibration from operation of the onshore seismic sources include those specified within Section 8.5.1 above in relation to noise in addition to the following:

- Restrict use of the seismic source to the period required to complete the survey at each source location.

### 8.6.2 Event Magnitude

As described within Section 8.5.2 above three types of seismic sources (AHV-IV vibroseis truck, UNIVIB small scale vibroseis truck and OnSeis unit) will be used to undertake the onshore seismic survey. The specification for each of these sources is provided within Chapter 4 Table 4.6. Regardless of the source type it is planned to operate the source at regularly spaced intervals of approximately 50m along survey lines approximately 400m apart across the onshore 3D Seismic Survey Area. Actual levels of vibration from seismic surveys are difficult to accurately predict as this is dependent on a number of factors including specific local ground conditions. However, it is possible to approximate the distance from the source at which the potential for damage to structures or disturbance to residents in local communities from groundborne vibration is minimised and below relevant thresholds. This can be achieved using reported field measurements of vibration levels during vibroseis operations. The following reported vibration levels were reviewed which relate to similar activities<sup>32,33</sup>:

- At a distance of 5m from vibroseis operations, PPV level of 19.3 mm/s was reported<sup>34</sup>;
- At a distance of 30m from vibroseis operations, PPV level of 5 mm/s was reported; and
- At a distance of 50m from vibroseis operations, PPV level of 1.32 mm/s was reported.

These levels were compared against relevant vibration limits.

Recommended Peak Particle Velocity (PPV) vibration limits for both structural and cosmetic damage for different types of structures are provided in BS 7385-2<sup>35</sup> and BS5228-2 (Part 2: Vibration), where cosmetic damage proceeds the onset of structural damage. The more stringent limits relating the cosmetic damage (i.e. the formation of hairline cracks or the growth of existing cracks in plaster, drywall surfaces or mortar joints) are given as:

- For reinforced or framed structures: PPV 50mm/s at 4 Hz and above; and
- For unreinforced or light framed structures and residential or light commercial type buildings:
  - PPV of 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz; and
  - PPV of 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above.

Comparing these thresholds with the reported data, cosmetic damage to all structures (including unreinforced or light framed structures which are potentially more susceptible to damage) is

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<sup>32</sup> Alcludia, A. D., Stewart, R. R., Eliuk, N., & Espersen, R. (2007). Vibration and air pressure monitoring of seismic sources. CREWES Res. Rep, 19, 14.

<sup>33</sup> Oriard, L. L. (1994). Vibroseis operations in an urban environment. Bulletin of the Association of Engineering Geologists, 31(3), 343-366

<sup>34</sup> As peak vector sum at frequencies above 20Hz

<sup>35</sup> BS 7385-2:1993 Evaluation and measurement for vibration in buildings — Part 2: Guide to damage levels from ground borne vibration.

considered to be unlikely at distances of more than 5m from the seismic source. It should be noted that the duration of each event will typically last seconds to minutes and as such would not represent a continuous vibration source. Seismic survey vibration by its nature will vary and for the majority of the survey vibration levels will be lower than forecast.

Thresholds relevant to human exposure to vibration relate to PPV levels and the potential for annoyance where levels provided within BS5228-2 (Part 2: Vibration) are:

- PPV of 1 mm/s where repeated occurrences at this level are likely to give rise to complaints from nearby residents, but can be tolerated if prior warning and explanation has been given to residents; and
- PPV of 0.3 mm/s, which may be just perceptible to nearby residents<sup>36</sup>.

On the basis of the anticipated vibration levels associated with the seismic source operation (based on the reported data), it is expected that at distances of more the 50m from the seismic source vibration from the survey would only just be perceptible. At distances of between 10m and 50m from the source it is expected that vibration may cause a nuisance to nearby residents. However, the vibration generated by the survey activity will be very short term and transient, and residents present in the vicinity of the survey will be made aware of the survey activities, the planned schedule and the potential for vibration prior to the survey commencing in accordance with the existing controls.

Table 8.24 presents the event magnitude associated with groundborne vibration due to operation of onshore survey sound source and use of the onshore survey vehicles.

**Table 8.24: Event Magnitude**

Parameter	Explanation	Rating
Extent / Scale	Vibration levels will be at a level just perceptible to human receptors and close to background levels within tens of metres from the source	1
Frequency	Vibration from the onshore survey activities will occur repeatedly but intermittently. Vibration due to the survey will only be experienced at any given receptor typically once or on a small number of occasions at worse.	1
Duration	Vibration energy dissipates with distance from the source and as the source is moving, vibration effects in any one location will last for a very short period of time, ceasing once the source has moved away from the receptor.	1
Intensity	Vibration will be transient, non-persistent and localised. With the implementation of the existing control measures, disturbance is expected to be minimal.	1
<b>Total</b>		<b>4</b>

### 8.6.3 Receptor Sensitivity

A number of different types of structures were observed in Priority Areas 1 and 3 during the walkovers described within Chapter 5 Sections 5.4.6 and 5.6.1 and within Chapter 6, ranging from framed/reinforced commercial and brick built buildings to shacks and shelters constructed from metal and/or wood. A number of greenhouses were observed within the agricultural areas of Priority Area 3. Unsecured walls (where there was no visible cement between the bricks) were also observed in Priority Area 3 dividing parcels of land. No structures other than the brick built hut at the entrance to the National Park and buildings within the military base were observed within Priority Area 2. As described within Section 8.5.1 above safety distances between seismic sources and existing infrastructure which includes buildings and structures will be defined by the seismic contractor and seismic lines will be offset to ensure these distances are maintained. Within Section 8.6.2 it was

<sup>36</sup> The IAGC guidelines equate this level of vibration to vibration that may be associated with slamming a door or walking across a room.

calculated that at a distance of 5m or more, vibration from the seismic survey source would be below relevant threshold where the onset of cosmetic damage to structures would begin.

Table 8.25 presents the justification for assigning a score of 3 to residential/community structures, which represents medium receptor sensitivity.

**Table 8.25: Receptor Sensitivity (Residential/Community Structures)**

Parameter	Explanation	Rating
Resilience	It is anticipated that with the implementation of a 5m buffer zone around all residential and community structures cosmetic damage due to vibration is not anticipated to occur.	1
Presence	Residential/community structures will be located in proximity to the survey activities. A number of structures have limited structural integrity and are sensitive to disturbance.	2
<b>Total</b>		<b>3</b>

The IAGC guidelines provide an overview of vibration levels generated by typical activities within a residential environment, such as walking across a room, slamming of a door, jumping and hitting a nail into a wall. Vibration levels for these activities are given as varying between 0.3m/s to 2mm/s. As such the vibration levels associated with the survey are expected to be within the range of background vibration already experienced by local residents, particularly those within more urban areas.

Table 8.26 presents the justification for assigning a score of 4 to human receptors, which represents medium receptor sensitivity.

**Table 8.26: Receptor Sensitivity (Human Receptors)**

Parameter	Explanation	Rating
Resilience	Vibration from the survey activities is expected to be just perceptible to residents at distances of 50m from source and at a level that may give rise to complaints within 10-50m of the source. Vibration from the survey is likely to be of very short duration, resulting in a brief nuisance to nearby receptors who have the capacity to tolerate the short term vibration and will be warned ahead of the survey activity.	1
Presence	Residential receptors will be located in proximity to the survey activities	3
<b>Total</b>		<b>4</b>

### 8.6.4 Impact Significance

Table 8.27 summarises impacts of vibration associated with the onshore survey activities.

**Table 8.27: Impact Significance**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Groundborne vibration due to operation of onshore survey sound source and use of the onshore survey vehicles	Low	Residential/Community Structures (Medium)	Minor Negative
		Human Receptors (Medium)	Minor Negative

The following monitoring and reporting related to groundborne vibration from the onshore survey activities will be undertaken:

- A vibration monitoring programme will be established during the onshore seismic survey as part of the Environmental and Cultural Heritage Management Plan with the aim of confirming vibration levels during the 3D Seismic Survey; and
- Results from the vibration monitoring surveys will be provided to relevant key stakeholders as specified within the Communication and Consultation Management Plan.

It is considered that potential impacts are minimised as far as practicable and necessary through the implementation of the existing mitigation measures and no additional controls are required.

## **8.7 Impacts to the Terrestrial Environment (Ecology) Due to Onshore Survey Activities**

Onshore survey activities as described in Section 4.5.1 of Chapter 4 have the potential to impact ecological receptors through disturbance and physical presence of the survey vehicles.

### **8.7.1 Mitigation**

To minimise potential impacts to onshore ecological receptors due to the onshore survey activities a number of control measures have been included in the project design. These include the following:

- Prior to the Seismic Survey commencing a programme of pre-planning surveys will be undertaken. These activities will inform the Seismic Survey design, including further informing the positioning of survey lines and which of the proposed onshore methods are suitable for which areas (i.e. vibroseis or OnSeis);
- There will be no planned vegetation clearance;
- Onshore survey personnel will be provided with environmental awareness training that communicating how to identify important areas, habitats and species present or potentially present within the survey area and what actions to take if these are encountered;
- Survey lines will be marked prior to commencing the survey using biodegradable markings (such as paint, chalk or biodegradable sand bags);
- Each survey lines will be inspected prior to commencing the survey. Where the survey team are unsure of the potential for protected species, and in the event these areas cannot be avoided, an on call ecological watching brief will be implemented;
- An on call ecological watching brief will be established using suitably qualified national ecologists to confirm and record the presence of any protected species. Where protected species are identified the watching brief ecologist will confirm the controls required to minimise or avoid impacts;
- The survey will be undertaken using the existing road network, but it will also be necessary to travel off road to access receiver and source points. Off road vehicle movements will be minimised as far as practical; and
- Vehicles movements will be minimised as far as possible.

### **8.7.2 Event Magnitude**

As described within Chapter 5, onshore survey activities include the movement of the seismic source vehicles and support vehicles along the seismic source lines, operation of the seismic sources, movement of the vehicles laying the nodes and placement of the nodes in the ground. It is anticipated that the movement of the node vehicles and the laying of the nodes will result in limited disturbance to the ground and to any vegetation present. Seismic trucks, however, are large heavy vehicles. The largest vibroseis trucks to be used during the survey are approximately 25 tonnes in weight with tyres of approximately 0.5m width. As the vehicles travel along the survey lines there is potential for any vegetation present within the direct line of the tyres to be disturbed. Based on the indicative survey lines within each Priority Area and conservatively assuming the survey is completed using the largest vibroseis trucks it is estimated that the tyres of the trucks will travel over a maximum area of land of approximately 175,000m<sup>2</sup> (approximately 0.24% of the land area within each Priority Area). However the majority of the open land within each Priority Area is disturbed, contains sparse or no vegetation or comprises crop or other non-native planting. As such it is estimated that a relatively small area of semi-natural habitat may be affected. Training of the survey team and the use of an on call ecological

watching brief where required is aimed at ensuring that potential disturbance or destruction of protected flora (only considered likely to be present in vegetated and undisturbed areas in Priority Areas 2 and 3) is avoided.

The movement of the trucks and operation of the seismic source also have the potential to affect faunal species with the in air sound and disturbance from the survey anticipated to be noticeable leading to avoidance behaviour to ecological receptors from tens of metres away to up to approximately 200m to 250m depending on the animal.

Within Priority Area 2 which lies adjacent to the Absheron National Park survey activities are planned to occur between June and September with the onshore activities lasting a period of weeks. Activities within 200 to 250m of the Park boundary would be expected to last days with the disturbance to any one receptor lasting minutes.

Table 8.28 presents the event magnitude associated with groundborne vibration due to operation of onshore survey sound source and use of the onshore survey vehicles.

**Table 8.28: Event Magnitude**

Parameter	Explanation	Rating
Extent / Scale	Direct physical disturbance of habitat is expected to be limited to immediate area around the tyres of the seismic trucks with sound and general disturbance noticeable to ecological receptors at distance of tens to hundreds of metres	1
Frequency	Once	1
Duration	The duration of the disturbance to any single receptor would be over a period of seconds to minutes as the survey passes	1
Intensity	In the event that a protected species is disturbed, the intensity of the event would be moderate or high. However with the implementation of the existing controls, including training and use of an on call ecological watching brief, direct physical disturbance to protected species is not expected to occur.	1
<b>Total</b>		<b>4</b>

### 8.7.3 Receptor Sensitivity

As discussed within Chapter 5 Section 5.4.6 the land across most of the Priority Areas has been disturbed by previous activity. Within Priority Area 1 the walkover survey undertaken in October and November 2015 indicated that the area is very unlikely to support any threatened or nationally important habitats and only the area to the north of Shikh which comprises some semi natural habitat and plantation is suitable to support species listed on the AzRDB<sup>37</sup> and the IUCN Red List of Threatened Species<sup>38</sup>. Four protected flora species of IUCN least concern and one AzRDB species (Eldar pine within an area of planted parkland) were recorded. The majority of reptiles and amphibians recorded or suspected to be present within Priority Area 1 which are IUCN listed are of “Least Concern” with the exception of European Pond Turtle and Spur-thighed Tortoise, which are IUCN Near threatened and Vulnerable respectively and also AzRDB listed. The European Pond Turtle is typically found in ponds and slow moving fresh water but mates and breeds on land near to water. Both European Pond Turtle and Spur-thighed Tortoise mate in the spring (March to May) and then nest (May to July) with turtles burying their eggs underground. Juvenile turtles then typically emerge between August and October but can stay underground until spring. Over winter Spur-thighed Tortoise hibernate, burying under bushes and trees.

Priority Area 2 comprises predominantly marshland (within 150m from the coast) and semi-arid habitat including sparse low vegetation crossed with tracks. All IUCN listed flora species recorded in

<sup>37</sup> Azerbaijan Ornithological Society, 2015, Threatened Bird Species in Azerbaijan. Available at: <http://www.aos.az/en/2013-01-10-09-21-19/threatened-bird-species-in-azerbaijan> Accessed August 2015

<sup>38</sup> IUCN, 2015, IUCN Red List of Threatened Species. Available at: <http://www.iucnredlist.org/> Accessed August 2015

this area were of Least Concern. With the exception of the suspected presence of Spur-thighed Tortoise, no species of conservation important greater than Least Concern were recorded.

Most of Priority Area 3 is developed land or has been disturbed including stripping of the topsoil. Areas of semi natural habitat are located predominantly within the north and east and, despite a level of disturbance and observed areas of contamination, were considered likely to support protected or notable habitats and species. IUCN listed flora species recorded in this area were of Least Concern however two species of AzRDB listed flora were also recorded or considered potentially present; iris (*Iris acutiloba*) (within and in the vicinity of the quarry area) and the pomegranate (*Punica granatum*) (planted within urban areas). As for Priority Area 1 the majority of reptiles and amphibians recorded or anticipated to be present within Priority Area 3 are IUCN listed “Least Concern” with the exception of European Pond Turtle and Spur-thighed Tortoise.

In all Priority Areas all IUCN listed mammals observed or suspected to be present (including a number of rodents, hedgehog, fox and jackal) are of Least Concern status. Within the National Park in addition to numerous bird species (refer to Section 8.4 above)<sup>39</sup>, species present (including species of conservation importance) include reptiles, amphibians and mammals. Suitable habitat for these species is understood to be located across the Park.

Reptile, amphibian and mammal species are all highly mobile and, in the event of a very short term disturbance have the capacity to move away, and return to the area once the disturbance has ceased.

In the event that vegetation is damaged by the survey activities across the onshore 3D seismic Survey Area it is anticipated that the effect would be temporary and reversible with recovery expected to occur within weeks and most quickly for herbaceous plants such as grasses and flowering plants particularly during spring and summer months. Late spring and summer are the most sensitive months for the European Pond Turtle and Spur-thighed Tortoise, however these species are not widespread across the Priority Areas and are expected to comprise individuals restricted to small areas of suitable habitat.

With the implementation of the existing controls, which includes training and use of an on call ecological watching brief where required, it is anticipated that this habitat would be identified and the potential for individuals to be present evaluated. Suitable actions would then be taken which may include relocating the animal away from the survey activities for the period of the survey.

Table 8.29 and Table 8.30 present the justification for assigning a score of 3 and 4 respectively to ecological receptors (flora and fauna) which represents medium sensitivity.

**Table 8.29: Receptor Sensitivity (Ecological Receptors - Flora)**

Parameter	Explanation	Rating
Resilience	Flora and vegetation within the vicinity of the survey activities may be directly affected but the effect would be reversible and recovery would be expected within weeks. No loss of ecological functionality is anticipated.	1
Presence	Vegetation across the majority of the Priority Areas is sparse and, where present, comprises a mix of semi natural vegetation and typical semi arid (inland) and marsh (coastal) species. All protected flora species recorded during the walkover survey were IUCN Least Concern or AzRDB species with the latter being either introduced within planting or in a very limited area (i.e. within the vicinity of the quarry within Priority Area 3). Vegetation present is of local importance to the ecosystem with protected species of national importance.	2
<b>Total</b>		<b>3</b>

The figure shows a horizontal scale from 1 to 6. The scale is color-coded: 1 is yellow (LOW), 2 is light orange, 3 is orange, 4 is dark orange, 5 is red, and 6 is dark red (HIGH). A circle is drawn around the number 4.

<sup>39</sup> Birds predominately use the coastline and main area of the Shahdili Spit away from the Park’s northern boundary.  
December 2015  
Draft

**Table 8.30: Receptor Sensitivity (Ecological Receptors - Fauna)**

Parameter	Explanation	Rating
Resilience	The majority of faunal species known or suspected to be present across the survey area are considered mobile with high potential to move in the event of a disturbance. Spur-thighed Tortoise suspected to be present in suitable habitat in all Priority Areas are known to nest in late spring then hibernate over winter. Similarly European Pond Turtle suspected to be present in suitable habitat in Priority Areas 1 and 3 nest between May and July, laying eggs underground. These species which are IUCN Vulnerable and Near threatened are therefore most sensitive at this time of year and have little or no capacity to move away from the physical survey disturbance.	3
Presence	Implementation of the existing controls includes avoiding areas where presence of European Pond Turtle and Spur-thighed Tortoise is suspected and the use of an on call ecological watching brief where required. As such it is considered unlikely a protected faunal species would be present in the direct line of the survey. Other species known to be present are expected to move away as the survey progresses.	1
<b>Total</b>		<b>4</b>

### 8.7.4 Impact Significance

Table 8.31 summarises the impact of the onshore seismic survey activities to ecological receptors.

**Table 8.31: Impact Significance**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Disturbance and physical presence of the survey vehicles	Low	Ecological Receptors (Flora) (Medium)	Minor Negative
		Ecological Receptors (Fauna) (Medium)	Minor Negative

It is considered that potential impacts are minimised as far as practicable and necessary through the implementation of the existing mitigation measures and no additional controls are required.

## 8.8 Impacts to the Cultural Heritage Due to Onshore Survey Activities

Vehicle movements and operation of the onshore seismic sources as described in Section 4.5.1 of Chapter 4 has the potential to impact known and unknown culture heritage sites across the onshore 3D Seismic Survey Area.

### 8.8.1 Mitigation

To minimise potential impacts to cultural heritage associated with the onshore survey activities a number of control measures have been included in the project design. These include the following:

- Prior to the Seismic Survey commencing a programme of pre-planning surveys will be undertaken. These activities will inform the Seismic Survey design, including further informing the positioning of survey lines and which of the proposed onshore methods are suitable for which areas (i.e. vibroseis or OnSeis);
- Safety distances between the seismic sources and existing infrastructure will be defined by the seismic contractor prior to the survey (during the mobilisation phase) in line with the current IAGC Minimum Offset Guidelines for Land Seismic Surveys<sup>40</sup>;
- Seismic lines will be offset to maintain safety distances from sensitive receptors calculated using relevant guidance and project specific parameters;

<sup>40</sup> International Association of Geophysical Contractors, 2007, Minimum Offset Guidelines for Land Seismic Surveys December 2015 Draft

- The seismic contractor will be required to plan the survey to avoid all survey activities over and immediately adjacent to known cultural heritage sites.
- Onshore survey personnel will be provided with cultural heritage awareness training which will include communicating the location of known cultural heritage sites and how to identify areas where there is potential for previously unidentified cultural heritage;
- Each survey lines will be inspected prior to commencing the survey. In areas identified by the survey team as having the potential for archaeological or cultural heritage remains, and in the event these areas cannot be avoided, the on call archaeological watching brief will be implemented;
- An on call archaeological watching brief will be established using representatives from the Institute of Archaeology and Ethnography (IoAE) to identify and record the presence of any cultural heritage sites or artefacts. Where sites or artefacts are identified the watching brief archaeologist will advise on the controls required to minimise or avoid impacts with notification of any finds provided to the Ministry of Culture and Tourism (MoCT).

### **8.8.2 Event Magnitude**

As described within Section 8.6.2 operation of the seismic sources will result in groundborne vibration, which has the potential to physically affect structures including historic monuments and sites. The criteria used to determine the vibration level at which the onset of cosmetic damage to structures may begin is described in Section 8.6.2 above. However, it is recognised that historic buildings and structures are considered of greater value than modern buildings and are often more fragile and susceptible to damage. As such more conservative vibration thresholds based on criteria developed by the British Museum<sup>41</sup> for the protection of historic buildings are considered to be applicable. These criteria, developed based on measured vibration levels, specify a guidance vibration level of 5mm/s PPV for the protection of historic structures (based on intermittent vibration). Based on actual vibration levels for seismic operations as described within Section 8.6.2 above it is estimated that this value would be reached at a distance of approximately 30m from the seismic source. Given the nature of the survey activities and distance between the source points, each vibration event will be very short term (seconds to minutes).

Historic monuments and sites may also be affected by the movement of the seismic sources vehicles and supporting vehicles along the seismic source lines and to a lesser extent by movement of the vehicles laying the nodes and placement of the nodes in the ground.

Seismic trucks are large heavy vehicles and their movements have the potential to damage surface and shallow archaeological remains such as pottery scatters and archaeological features. Section 8.7.2 above sets out the estimated area of land within each Priority Area that may be directed affected by the seismic source vehicles (based on a conservative assumption that vibroseis trucks are used for all survey activities.). The anticipated presence of unknown archaeological sites across the Priority Areas cannot be definitively stated however, based on previous finds across the area during earlier archaeological investigations, it is possible that sites may be present, particularly in areas of undisturbed ground. The implementation of the existing controls listed above including use of an on call watching brief are aimed at allowing these sites to be identified and avoided.

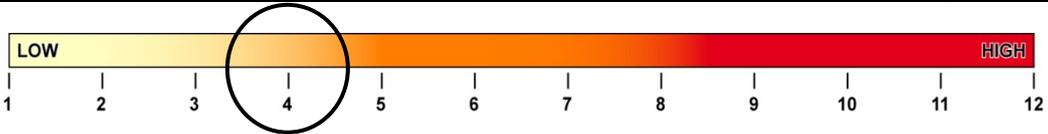
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<sup>41</sup> 2010, Vibration recommendation, Department of Conservation and Scientific Research, British Museum  
December 2015  
Draft

Table 8.32 and Table 8.33 presents that justification for assigning a scores of 4 and 4 respectively to groundborne vibration and physical disturbance associated with the onshore survey activities affecting cultural heritage which represents medium and low event magnitude respectively.

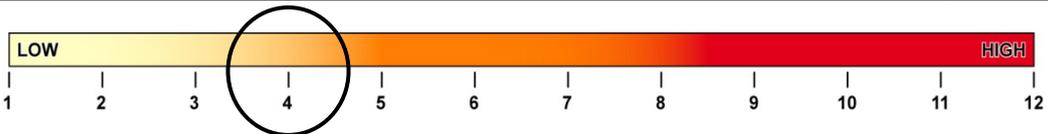
**Table 8.32: Event Magnitude (Groundborne Vibration)**

Parameter	Explanation	Rating
Extent / Scale	Vibration levels below relevant threshold levels associated with potential damage to cultural heritage buildings and structures within tens of metres from the source	1
Frequency	Vibration from the onshore survey activities will occur repeatedly but intermittently. Vibration due to the survey will only be experienced at any given receptor typically once or on a small number of occasions at worse.	1
Duration	Vibration energy dissipates with distance from the source and as the source is moving, vibration effects in any one location will last for a very short period of time, ceasing once the source has moved away from the receptor.	1
Intensity	Vibration will be transient, non-persistent and localised. With the implementation of the existing control measures, including the use of a project specific buffer zone of 30m around all known cultural heritage buildings and structures, the effect of vibration is expected to be minimal.	1
<b>Total</b>		<b>4</b>



**Table 8.33: Event Magnitude (Physical Disturbance)**

Parameter	Explanation	Rating
Extent / Scale	Effect will be limited to the immediate vicinity of the survey vehicles	1
Frequency	Once	1
Duration	The duration of the disturbance due to the survey vehicles would be over a period of seconds.	1
Intensity	In the event that a cultural heritage feature is damaged, the intensity of the event would be moderate or high depending on the value of the feature and the extent of damage. However with the implementation of the existing controls, including use of an on call watching brief and chance finds procedure physical disturbance to cultural heritage features is not expected to occur.	1
<b>Total</b>		<b>4</b>



### 8.8.3 Receptor Sensitivity

As described within Chapter 5 Section 5.6.1 there are a number of known cultural heritage sites across the onshore 3D Seismic Survey Area. These include two groups of Bronze Age burial mounds located northeast of Hovsan and north of Turkan, which are nationally designated sites and prehistoric stone-cut trackways or cart-ruts between Turkan and Hovsan, which are associated with the mounds northeast of Hovsan and are surrounded by a Protection Zone designated by the Ministry of Culture and Tourism (MoCT). These sites are located within Priority Area 2. In addition three further sites are in the process of being nationally designated, all within Priority Area 1, including:

- the modern mosque at Bibiheybat;
- the graveside memorial of an oil pioneer at Bibiheybat; and
- the 9<sup>th</sup> to 12<sup>th</sup> century medieval settlement core of Bibiheybat.

One late medieval pottery scatter located on sand dunes and the coastal plain in the south of Area Priority Area 2, near the coastline was identified during the cultural heritage walkover during November 2015 and could be a candidate for the national inventory.

Other sites recorded during the November 2015 survey included a possible former post-medieval settlement, with upstanding ruins, west of Zira, a disused military base southwest of Zira, and possible historic military structures and enclosures in the east of Area Priority Area 2. In addition modern war memorials associated with the Nagorno-Karabakh conflict were also found in Priority Areas 1 and 2. None of these sites are nationally listed but are of cultural significance. Similarly the locations of five cemeteries, also of cultural importance, which are currently in use was also recorded during the survey.

With regard to unknown cultural heritage sites previous intrusive investigations across the Absheron Peninsula (refer to Appendix 5D) have recorded archaeological remains dating from the Palaeolithic to the post-medieval period. However, as noted during the walkover survey extensive parts of the onshore 3D Seismic Survey Area have been subject to urban, industrial, military and agricultural development, limestone and sand quarrying, oil exploration and land reclamation. Other areas have been subdivided by property boundaries. These activities have resulted in the widespread loss of archaeological remains. In areas across the onshore 3D Seismic Survey Area that have been subject to little or no development or ground disturbance, there is a moderate to high potential for the presence of further archaeological sites. These sites may have survived relatively intact and would be vulnerable to physical direct impact from survey activities.

Table 8.34 presents the justification for assigning a score of 4 to cultural heritage which represents medium sensitivity.

**Table 8.34: Receptor Sensitivity (Cultural Heritage Receptors)**

Parameter	Explanation	Rating
Resilience	Known protected monuments (comprising Bronze Age burial mounds and tracks) and those monuments which are in the process of being listed are generally not highly vulnerable to vibration due to their construction however their protected status is recognised.  Both known and unknown sites would be highly vulnerable to direct physical disturbance associated with vehicle movements and the operation of the seismic source, which could result in severely damaging or destroying the sites and associated artefacts.	3
Presence	There are a number of state protected monuments located within the 3D Seismic Survey Area, however given that their locations are known the Survey will plan to avoid these locations. Therefore, state protected monuments are not expected to be present along the routes to be taken the survey vehicles. In addition a buffer zone will be implemented around the known cultural heritage buildings and structures to minimise the potential for damage due to vibration.  The presence of unknown sites is considered to be moderate to highly likely in the more undisturbed areas across the 3D Seismic Survey Area. However, with the adoption of existing controls including an on call watching brief, should an unknown site be identified the Survey will take precautions to avoid this area.	1
<b>Total</b>		<b>4</b>

### 8.8.4 Impact Significance

Table 8.35 summarises impacts on cultural heritage from groundborne vibration and vehicle movements associated with the onshore SWAP 3D Seismic Survey.

**Table 8.35: Impact Significance**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Groundborne vibration due to Onshore Survey Activities	Low	Cultural Heritage Receptors (Medium)	Minor Negative
Physical disturbance due to Onshore Survey Activities	Low		Minor Negative

The following monitoring and reporting related to onshore cultural heritage will be undertaken:

- A summary of the on-call watching brief findings to be issued to the MoCT and IoAE at completion of seismic survey activities

It is considered that potential impacts are minimised as far as practicable and necessary through the implementation of the existing mitigation measures and no additional controls are required.

## 8.9 Summary of Residual Environmental Impacts

The assessments presented within the Chapter show that that potential impacts are minimised as far as practicable and necessary through the implementation of the existing control measures and additional mitigation measures relating to underwater sound.

Table 8.36 summarises the residual environmental impacts associated with the routine and non-routine SWAP 3D Seismic Survey activities.

**Table 8.36: Summary of SWAP 3D Seismic Survey Residual Environmental Impacts**

Event	Event Magnitude	Receptor Sensitivity	Impact Significance
Underwater sound from energy source	Medium	Low(Fish)	Minor Negative
		High (Seals)	Moderate Negative
Offshore Survey Activities	Medium	Overwintering and Migrating Birds (Medium)	Moderate Negative
		Nesting Birds (Medium)	Moderate Negative
		Absheron National Park (Medium)	Moderate Negative
In air sound arising from onshore survey activities, including vehicle movements and operation of the seismic source	Low	Human Receptors (Medium)	Minor Negative
Groundborne vibration due to operation of onshore survey sound source and use of the onshore survey vehicles	Low	Residential/Community Structures (Medium)	Minor Negative
		Human Receptors (Medium)	Minor Negative
Disturbance and physical presence of the survey vehicles	Low	Ecological Receptors (Flora) (Medium)	Minor Negative
		Ecological Receptors (Fauna) (Medium)	Minor Negative
Groundborne vibration due to Onshore Survey Activities	Low	Cultural Heritage Receptors (Medium)	Minor Negative
Physical disturbance due to Onshore Survey Activities	Low		Minor Negative

## 8.10 Additional Recommendations

As stated within Chapter 5 Section 5.5.6.3 recent data relating to seal migration and numbers within Azerbaijani waters and seals observed at haul out sites within Azerbaijan is not comprehensive and uncertain. Scientific surveys have tended to focus on the winter ice fields in the Northern Caspian with annual surveys undertaken between 2005 and 2012 by the Caspian International Seal Survey in liaison with the Darwin Caspian Seal Project and the Caspian Seal Conservation Network (CSCN).

The most recent data collected within Azerbaijan has been focused on observed usage of known haul out sites, counting of dead seals found on the Azerbaijan coastline and ad hoc observations from vessels and helicopters<sup>42</sup>. To improve the understanding of seal movements within Azerbaijan waters (particularly in the vicinity of the SWAP Contract Area) including migration routes used, timing of migration, numbers using each migration route and location and numbers using haul out sites within Azerbaijan BP have consulted with marine ecologists, both national and international, to design and set up a fit for purpose Annual Seal monitoring programme.

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<sup>42</sup> It should be noted that during the SWAP 2D Subsea Hazard Survey, SWAP 2D Seismic survey, Shah Deniz North East Seismic Survey and the SWAP environmental sampling survey, crew members undertook marine mammal observation. This data has been provided to the MENR and will be made available to the existing seal monitoring programme.