SEA for Petroleum Activities

In Lebanese Waters

2011/2012

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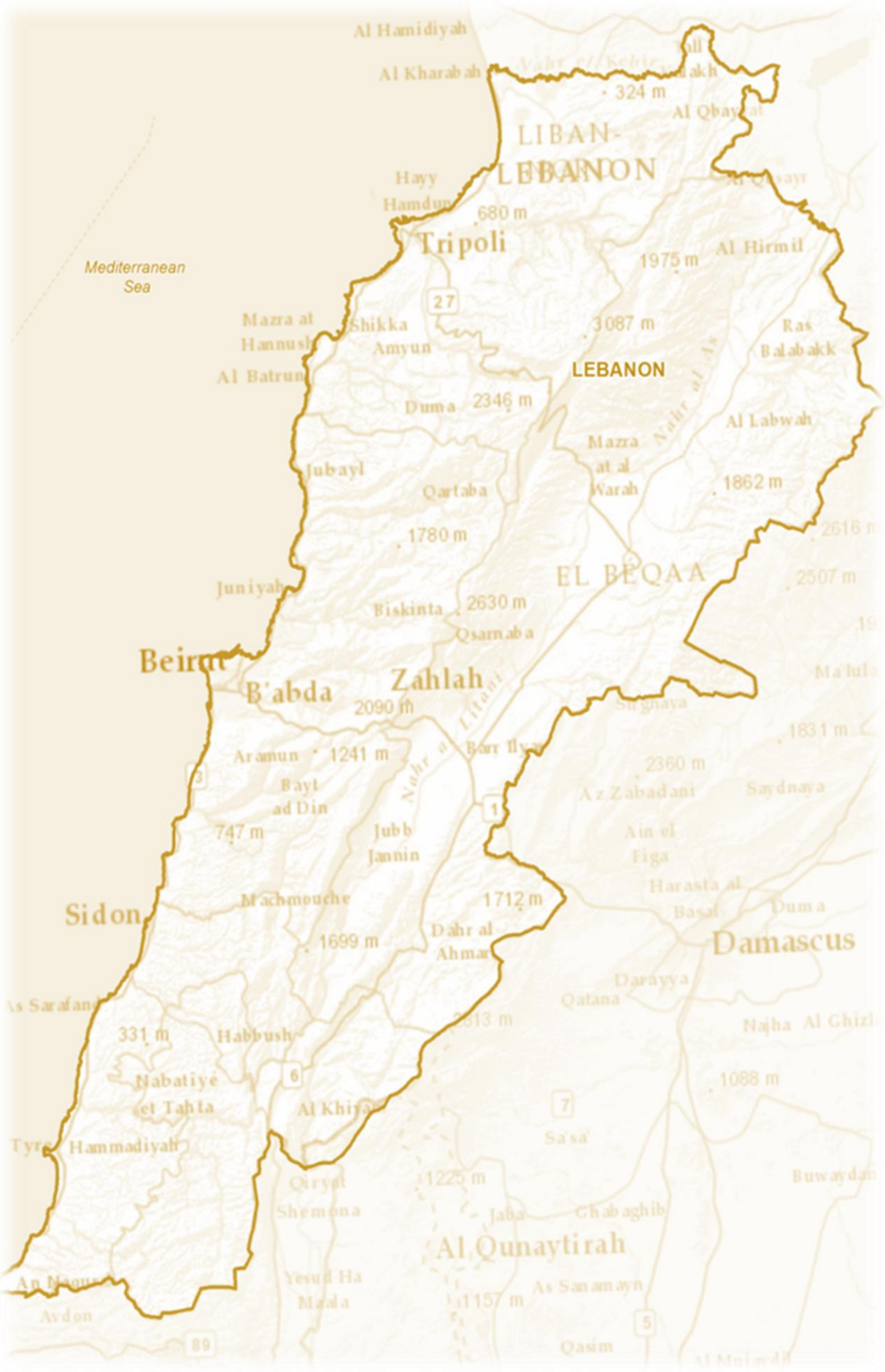
REPUBLIC OF LEBANON
MINISTRY OF ENERGY AND WATER

RPS Energy


Al Hamidiyah
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Al Qunaytirah
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1. PROJECT INTRODUCTION

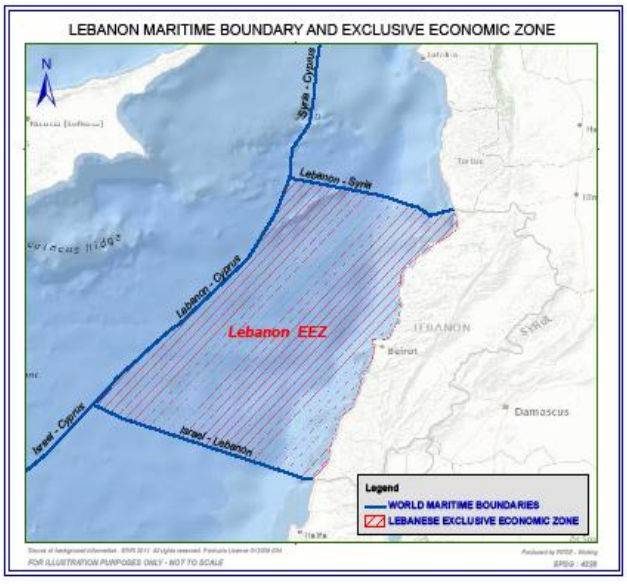
RPS Energy Ltd has been awarded the contract to develop a Strategic Environmental Assessment for the Offshore Petroleum Sector in Lebanon on behalf of the Ministry of Energy and Water. This also includes the provision of consultancy support to the Ministry.

Lebanese territorial waters (Exclusive Economic Zone) are part of the deep Levantine Basin where there are proven petroleum resources. The Lebanese offshore area covers a total of 22,730km^2 in the Eastern Mediterranean and has never been previously licensed for hydrocarbon exploration. The recent deepwater, sub-salt gas discoveries to the South, which encountered high quality Lower Miocene sands, have significantly increased the industry interest in Lebanon and the Eastern Mediterranean. The Levantine basin within the Eastern Mediterranean region is regarded to contain some of the most exciting exploration plays in the region which are being re-evaluated through advances in seismic technology.

The Lebanese Government is in the process of preparing the first offshore exploration and production licensing round. To support these ongoing preparations, and ensure that negative impacts are controlled and minimised and any benefits are maximised, the Government of Lebanon has commissioned a comprehensive Strategic Environmental Assessment (SEA).

It is likely that drilling will be carried out in areas presenting technical challenges as the Levantine Basin includes deep water and is also an earthquake zone. Oil and Gas developments and support services onshore are constrained by the urban development that occupies so much of the land along Lebanon's littoral.

Strategic Environmental Assessment is the process of appraisal through which environmental protection and sustainable development may be considered, and factored into national and local decisions regarding Government plans and programmes – such as oil and gas licensing rounds and other offshore and onshore energy developments. The process aims to help inform Ministerial decisions through consideration of the environmental and social implications of the proposed action; it is a means of striking a balance between promoting economic development of offshore energy resources and effective environmental and community protection.



2. PURPOSE

It is standard practice to carry out a comprehensive Environmental and Social Impact Assessment prior to significant development projects. Environmental and Social baseline data is intended to establish the environmental conditions prior to the commencement of any oil and gas exploration operations. Given inevitable potential changes in the environment and communities caused by the oil and gas activities, impact monitoring surveys are carried out after the main operational phases of the project (construction, drilling, decommissioning) are completed. The comparison of baseline and impact monitoring surveys enables identification of any environmental changes caused by petroleum activities in the operational area.

The quality of Environmental and Social impact Assessment Studies will be judged largely by the scientific rigour and methodology of the field studies undertaken. This document describes the various methods and sampling procedures that will be used during the field surveys to ensure consistency across the project and to the standard required by RPS Energy.

Environmental monitoring activities, laboratory analysis and reporting/interpretation of data are not dealt with in this document.

Whenever a volume of water, soil, sediment or air is to be characterised, or a plant, animal or human population is to be represented, it is generally impossible to examine the whole and therefore necessary to take samples. Sampling is a process used in statistical analysis in which a predetermined number of observations will be taken from a larger population. The methodology used to sample from a larger population will depend on the type of analysis being performed, but will include simple random sampling, systematic sampling and observational sampling. The samples collected should be as fully representative as possible of the whole, and all precautions should be taken to ensure that, as far as possible, the samples do not undergo any changes in the interval between sampling and analysis.

As such, this document is concerned with ensuring the highest possible quality of sampling throughout environmental and social surveys undertaken by, or on behalf of, RPS Energy.

Some of the sections in this document describe sampling techniques that are rigid and regulated by ISO guidelines; while other sections describe surveys which in their nature are specific to location or culture, and initial feedback determines the future approach. For the latter the instructions in this manual are therefore less specific and technical.

Ultimately, this document has a practical application. It provides technical information to assist the auditing process and ensure audits that are carried out by different teams, at different times, in different locations maintain an inner consistency. And secondly, as surveys may well be conducted piecemeal in different Licensing Blocks and/or by different Contractors at different times, the Instruction Manual will enable the Ministry of Energy and Water and the Ministry of Environment to word the contracts in such a way that each survey is a building block in an overarching Survey Programme.

3. SCOPE

In Lebanon the coastal shelf drops off very sharply, therefore offshore petroleum activities will take place in deep water. Survey methodologies described in this document will take account of this and describe techniques suitable for sampling at depths varying between 500-2000 meters.

This document covers the following aspects:

- General Considerations for Environmental Surveys, such as
    - Health and Safety
    - Field Documentation
    - Geodata Format
    - Cross Contaminations issues & De-contamination Procedures
    - Field Probe (Maintenance, Calibration, etc.)
    - QA/QC Sampling
    - Sample Containers, Storage and Transportation
    - Chain of Custody Requirements
    - Electronic Reporting Requirements
- Offshore Survey Field Methodologies
    - Vessel Positioning, Hydrographic, Seawater, Sediment and Flora/Fauna Sampling Methods
- Onshore Survey Field Methodologies
    - Soil, Sediment, Groundwater, Surface Water, Air, Flora and Fauna Sampling Methods
- Social Field Methodologies
    - Community Questionnaire, Community engagement,
- Cultural Heritage

4. REGULATORY CONTEXT

This document is written within the context of both internationally recognised standards and Lebanon standards, where available.

Lebanon is applying for accession to WTO (World Trade Organisation) and a pre-requisite of membership under the TBA Annex (Technical Barriers to Trade) is that if an International Standard exists then it should be applied nationally. As a consequence of the accession application it is assumed that Lebanon have adopted International Standards.

The methodologies provided within this Instruction Manual have been written within the context of ISO guidelines. Where further guidelines and standards exist, for example IFC Performance Standards and

Equator Principles, these have been consulted and used where appropriate. Lebanon lacks a regulatory framework that can be applied to this level of work, but where standards exist they will be incorporated.

The relevant ISO standards that have been referenced in this Manual are detailed within the relevant sections. Additionally, a summary of all guidelines used in the production of this Field Manual is provided as Annex A.

5. ROLES AND RESPONSIBILITIES

This document shall be maintained and updated by RPS Energy HSE&RM. Re-issued versions shall be distributed to all relevant teams involved in managing and/or undertaking environmental and social baseline and monitoring surveys.

6. GLOSSARY OF TERMS

Accuracy – the closeness of agreement between a test result and the accepted reference value.

Blank – observed value obtained when measurement is made on a sample identical to the sample of interest, but in the absence of the determinand.

Bottom Sediment – solid material deposited by settling from suspension onto the bottom of bodies of water, both moving and static.

Chain-of-Custody Procedure - procedure to ensure sample integrity, e.g. when transferred between the field and laboratory and within a laboratory, and to ensure the sample will provide legally and technically defensible data.

Colonial - a group of animals, insects or plants of the same type that live together.

Composite sample/Average sample/Aggregate sample - two or more increments/subsamples mixed together in appropriate proportions, either discretely or continuously (blended composite sample), from which the average value of a desired characteristic may be obtained.

Cross Contamination – undesired result due to (i) the collection of a sample with uncontrolled mixing of material from different location/layers, etc. or (ii) the addition of chemical substances to a sample from sampling devices, devices, containers, reagents of preservation, by transport conditions, means of preparation, or during analytical processing.

Decantation – The withdrawal of the supernatant liquor after settlement of suspended solids, or after separation from a liquid of higher density.

Deionisation (as in deionised water) – partial or nearly complete removal of ionic species, particularly by the use of ion-exchange resins.

Demersal* - Organisms dwelling at or near the bottom of the sea or other body of water.

Distillation (as in distilled water) – process of evaporation followed by condensation used, for example, to prepare water of high purity.

Disturbed Sample – sample obtained without any attempt to preserve the soil or sediment structure.

Filtration – treatment process whereby water is passed through a porous layer of material in order to remove particulate matter.

Groundwater – water which is being held in, and can usually be recovered from, an underground formation.

Headspace - vapour phase contained in a closed system, equilibrium with the sample material (liquid, solid or mixture).

Homogeneity/Heterogeneity – degree to which a property or a constituent is uniformly distributed throughout a quantity of material. Note: A material may be homogeneous with respect to one analyte or property but heterogeneous with respect to another. Note: The degree of heterogeneity (the inverse of homogeneity) is the determining factor in sampling error.

Infauna - Animals living below the surface of sea bottom sediments. They usually burrow or build tubes in the sediment

Laboratory Precision – the ability of the analysing laboratory to reproduce analytical data for the same sample within an accepted/acknowledged range

Macrobenthos* - group of sediment-inhabiting animals large enough to be retained on a screen with mesh size of 0.5mm. Macrobenthic samples can be processed through a 1.0mm (100µm) sieve if in shallow water. 0.5mm sieves are used for deeper water or finer sediments. There has been a recent push from the US to establish a standard deepwater sieve size of 0.3mm as the organisms that are found at depths greater than 1000m are typically smaller as a result of the harsh environment that they live in. The risk of using a 50µm sieve in deep water is that a representative sample of benthic macrofauna is not collected.

Macrophyte* - Any plant species that can be readily observed without the aid of optical magnification.

Meiobenthos* – group of sediment-inhabiting animals passing through a 0.5mm sieve and being retained on a 45µm sieve, (i.e. animals smaller than macrobenthos and larger than microbenthos). Meiofauna is typically collected on a 30µm sieve. Offshore the samples are usually collected and fixed, unsieved. The sieving typically occurs in the analytical laboratory.

Microbenthos* – sediment-inhabiting animals that pass through a 45µm sieve, also referred to a single-celled sediment-inhabiting animals.

Pelagic* - fish (and animals) that live and feed in the open sea, away from the sea bottom

Phytoplankton – plants present in plankton.

Plankton – organisms drifting or suspended in water column, consisting chiefly or minute plants or animals (but including larger forms)

Precision – the closeness of agreement between independent test results obtained under prescribed conditions. Note: (i) Precision depends only on the distribution of random errors and does not relate to the true value or the specified value. (ii) The measure of precision is usually expressed in terms of imprecision and computed as a standard deviation of the test results. Lower precision is reflected by a larger standard deviation.

Preservative - the usual types of preservative agent for faunal samples, typically 4% formal saline mix (borax buffer optional)

Pycnocline – A layer in a stratified body of water in which the density gradient is at a maximum.

Repeatability – precision under repeatability conditions.

Replicate [duplicate] Sample - one of the two or more samples or subsamples obtained separately at the same time by the same sampling procedure or sub-sampling procedure Note 1: Adapted from ISO 3534-1. Note 2: Although the replicate samples are expected to be identical, often the only thing replicated is the act of taking the physical sample. Note 3: A duplicate sample is a replicate sample consisting of two portions. Note 4: The umpire sample is usually used to settle a dispute, the replicate sample is usually used to estimate sample variability.

Representative Sample - sample resulting from a sampling plan that can be expected to reflect adequately the properties of interest in the parent population. Note: A representative sample may be a random sample or, for example, a stratified sample, depending upon the objective of sampling and the characteristics of the population. The degree of representativeness of the sample may be limited by cost or convenience.

Sample – portion of material selected from a larger quantity of material.

Sample Container - recipient for storage and/or transportation of a sample, adapted to the type of sample and the kind of subsequent examination or analysis.

Sample Preservation - any procedure used to stabilize a sample in such a way that the properties under examination are maintained stable from the collection step until preparation for analysis.

Sample Stabilisation - process which is intended to minimise, by addition of chemicals or change of physical conditions, or both, the changes in characteristics of species of interest during the period from time of sampling to the time of examination

Sample Storage - process and the result of keeping a sample available under predefined conditions for a usually-specified time interval between collection and further treatment of a sample.

Sample Transportation - act of transferring a sample from the locality of sampling to the place of subsequent treatment (e.g. laboratory, soil-specimen bank etc.).

Sampling – process of drawing or constituting a sample.

Sampling Error - that part of the total error (the estimate from a sample minus the population value) associated with using only a fraction of the population and extrapolating to the whole, as distinct from analytical or test error.

Sampling Procedure – operational requirements and/or instructions relating to the use of a particular sampling plan

Sediment – material transported by water from the place of origin to the place of deposition.

Selective Sample - sample that is deliberately chosen by using a sampling plan that screens out materials with certain characteristics and/or select only material with other relevant characteristics. Note: The procedure is also referred to as "targeted sampling".

Spike – known quantity of a determinand which is added to a sample, usually for the purpose of estimating the systematic error of an analytical system by means of a recovery exercise.

Surface Water – water which flows over, or rests on, the surface of a land mass

Transect - sample area, usually elongate or linear, chosen as the basis for studying a particular characteristic of the environment.

Undisturbed Sample – sample obtained using a method designed to preserve the soil or sediment structure.

Zooplankton – animals present in plankton.

7. GENERAL CONSIDERATIONS FOR ENVIRONMENTAL SURVEYS

The following sections describe activities and practices that are applicable to both Offshore and Onshore Environmental Survey activities.

7.1. Health and Safety

The health and safety of all staff is a priority concern to RPS Energy. To ensure that health and safety aspects of each environmental and social survey are appropriately addressed, either by RPS Energy or the survey contractor, RPS Energy require a Health and Safety Work Plan to be produced prior to commencement of each survey.

The Health and Safety Work Plan must detail the scope of works to be undertaken during the survey and identify the key risks associated with the activities set out in the scope of works. Individual risk assessments must be completed for each field activity to be undertaken. For each activity potential risks and subsequent mitigation measures must be identified. This includes any specific mitigation measures as well as the use of specific Personal Protective Equipment.

Special requirements for the safe storage, handling and disposal of chemicals and samples must also be documented within the Health and Safety Plan.

The Health and Safety Work Plan must also identify the key personnel responsible for Health and Safety during the fieldworks and nominate a qualified first aider(s) for the works.

Emergency telephone numbers and contacts must be identified within the Plan as well as the actions that will be required in the event of an emergency. All incidents, including those that do not require emergency action, must be recorded and reported within an incident reporting procedure.

A general outline of the types of hazards that can be encountered during Onshore Surveys and the subsequent considerations, mitigation measures and types of Personal Protective Equipment to consider is provided in ISO 10381-3:2001 – Soil Quality – Sampling - Part 3: Guidance on Safety. Offshore Surveys tend to be regulated through guidelines and protocols rather than ISO Standards.

De-contamination of equipment requires the use of chemicals. All field personnel must be briefed by the Field Team Leader before conducting sampling on the hazards and safe handling requirements of these chemicals on site.

Personnel must avoid direct contact with all chemicals and avoid breathing fumes. Contact with solvents will cause irritation of eyes, nose, throat and skin. The following guidelines should be followed when handling chemicals:

- Wear chemical protective gloves
- Wear safety glasses
- Work in a well ventilated area
- Do not have any flames or ignition sources in the vicinity of the decontamination activities
- Use a respirator in enclosed spaces
- Store chemicals securely

7.2. Fieldwork Documentation

All fieldwork activities and relevant information must be recorded using legible notation and be clear, comprehensive and complete. The objective is to record all fieldwork activities in a clear format so that they may be easily understood by any other third party that has not been involved in the fieldworks or is undertaking subsequent monitoring.

A clear written description of important information is paramount when undertaking fieldwork to ensure the activities undertaken can be researched at a later date in the event of an anomalous result, or simply as part of an ongoing monitoring programme. Metadata and information such as instrument calibrations, any Health and Safety issues, must be clearly recorded. Copies of field documentation must be retained and available for review for up to five years following completion of the survey.

Typical daily notes, recorded on a standard form, should include the following metadata:

- Date/Time
- Time for each of the activities undertaken throughout each day
- Location/Sampling point/vessel position
- Field Survey Team – Names and Roles
- Survey progress status
- Survey plan for the day
- Communication and Navigation remarks
- Details of prevailing weather conditions
- Sampling details/logs/findings
- Calibrations and measurements from field instrumentation
- Water level data (groundwater monitoring wells)
- Well development/purging data
- Details of meetings with 3rd parties/vessel personnel/stakeholders
- Details of equipment breakdowns/standing time
- Dispatch dates and times for samples

Photography shall also be used to compliment the written notes. General photographs of the site and surroundings, sample locations, equipment used and of other observations shall be taken. Photographs from the same location will be used as part of a monitoring programme. Scale references should be used where required. For each photograph taken, the following data shall also be recorded:

- A photograph reference ID
- GPS reference
- A description of the shot/reason for taking shot
- Date and time
- Direction of the shot (e.g. looking north/south/east/west)
- Position that photograph was taken (i.e. geo-reference)

7.3. Position Recording – GeoData Collection

All field data collected using a handheld GPS (Global Positioning System) is recorded in WGS 84. Co-ordinates shall be recorded in decimal degrees to 5 decimal places. Surveyors shall not carry out grid co-ordinate conversions (i.e. UTM or other metric systems); these will be undertaken in-house.

8. SAMPLING PROCEDURES

Sampling is an integral part of field survey and the results determine policy and strategic decisions within the project. The scientific integrity of the sample is paramount and adherence to procedures that support quality control and assurance is an essential component of the work. Industry Best Practice,

supported by ISO Standard guidelines, are prescriptive in the procedures to be followed, especially in the areas of work and methodologies that require chemical analysis and laboratory support.

Calibration of equipment is an integral component of scientific rigour and assuring quality. Manufacturers recommendations for equipment calibration will be followed implicitly.

8.1. Cross contamination /Decontamination Procedures

Whichever method is used to collect a sample, it is important to ensure that the sampling system does not introduce any materials or chemicals that may contaminate the sample being collected.

Activities that require the use of non-disposable equipment require de-contamination (cleaning) between sample locations to ensure the potential for cross-contamination is minimised.

Samples could be cross-contaminated with residues from previous samples (which could be present on the sampling device), air borne contaminants (wind blown dusts/soils, etc.), liquids/precipitation, or contact with auxiliary substances used to enable or facilitate the sampling (fuels, exhaust fumes, greases, oils, lubricants, glues, etc.). To avoid cross contamination the deployment winch cable should not be greased as this can lead to hydrocarbon contamination of the sediment.

During ALL sampling activities that have the potential for cross-contamination, disposable latex gloves shall be worn by the person(s) undertaking the sampling to ensure there is no transfer of contaminants. The gloves shall be discarded after completion of activities at each survey location.

“Only devices of controlled chemical quality and composition shall be used to handle samples. For example, a hand trowel of stainless steel can be useful when investigating organic compounds, while plastics normally do not interfere with heavy metals. Devices that have contact with samples shall never be painted, greased or have otherwise chemically treated surfaces.” (ISO 10381-2:1002 Soil Quality – Sampling – Part 2: Guidance on Sampling Techniques)

Whilst the above paragraph is taken from the ISO guideline on Soil Sampling, the principles apply to all matrices (soil/sediment and water samples) in both Onshore and Offshore surveys. As such, all non-disposable equipment, used in both Offshore and Onshore surveys, requires cleaning – or de-contaminating – in between different sample locations to ensure the potential for cross-contamination is minimised as far as reasonably practicable. For decontamination procedures, the following equipment is required:

- Large rubber gloves, overalls and eye protection;
- Clean buckets;
- Scrubbing brushes;
- Laboratory grade detergent;
- Laboratory grade de-ionised water;
- Laboratory grade methanol;
- 10% Nitric Acid (laboratory grade nitric acid, diluted with the laboratory grade de-ionised water to 10%). This should be mixed prior to the commencement of fieldworks.

The use of methanol and 10% nitric acid during fieldwork activities requires clearly defined procedures to be in place for the storage, transportation and use of these chemicals as well as the storage and disposal of waste products from the de-contamination procedure. These should be clearly defined in the Health and Safety Work Plan. Material Safety Data Sheets will be required to be carried at all times with these chemicals during the survey works.

The procedure for undertaking de-contamination of equipment is as follows:

1. Put on Personal Protective Equipment
2. Scrub equipment in bucket of tap water and small quantity of laboratory detergent to clean off particulate matter, surface films, heavy debris, etc.
3. Rinse with tap water;
4. Rinse through equipment with de-ionised water;
5. Rinse through equipment with 10% nitric acid;
6. Rinse through equipment with de-ionised water;
7. Rinse through equipment with methanol;
8. Triple rinse with de-ionised water.

(Cleaning the sediment sampler with isopropyl alcohol can be an alternative to nitric acid cleaning, although an irritant/corrosive substance is being replaced with a flammable one.)

The procedure should be employed to decontaminate non-disposable equipment between samples. If field equipment cannot be cleaned using these procedures then it must be discarded for the remainder of the survey (until it can be appropriately de-contaminated at the equipment base).

It is envisaged that de-contamination procedures will be undertaken over large collecting vessels, e.g. clearly labelled 40 litre drums, which should be able to contain all waste chemical liquids from the decontamination process. Lids must be secured and the waste liquids stored until they can be disposed of safely.

Decontaminated sampling equipment must never be allowed to become re-contaminated prior to sampling. To avoid this, equipment must be decontaminated immediately prior to use or the equipment must be protected by wrapping in Teflon film, although, in practice there may be insufficient time and space to do this decontamination procedure offshore.

Good laboratory practices should be adhered to at all time; specifically “clean” equipment should not come into contact with anything other than the sample, air, or other “cleaned” equipment. This precludes contact with the ship’s deck, soil (except for the actual soil sample), hands, clothing, bags, buckets, trays, etc. One equipment (rinseate) blank sample must be collected for each survey where the above procedure is employed in order to assess the potential for contamination. This is described below.

Field probes require only minimal decontamination between samples, typically consisting of a rinse through with distilled water, as the integrity of the samples for probe readings are unlikely to be

affected. Larger items, such as submersible pumps, require a different procedure for decontamination as the above process would prove impractical in the field. This is described below.

8.2. Field Probe – Operation & Maintenance

Field measurements of water samples (seawater, groundwater and surface water) are taken using a field probe (typically a Horiba U-10). In offshore surveys these are collected at a range of depths, as described below.

- Where the water depth is less than 5m, probe readings are taken only at the surface layer, i.e. within the top 1m.
- Where water depth is greater than 5m, field probe readings are collected at two depths:
  - Upper - within the limits of surface 1m layer;
  - Lower - at a depth no less than 0.5 m above the seabed (to avoid sediment interference); and
- Where water depth is greater than 10m, field probe readings are collected at three depths:
  - Upper - within the limits of surface 1m layer;
  - Lower - at a depth no less than 0.5 m above the seabed (to avoid sediment interference); and
  - At / around the thermocline – the point at which temperature change is at a maximum, indicating a mixing of two separate water bodies.

The parameters and units recorded are as follows:

- Temperature (°C)
- Salinity (‰)
- Dissolved Oxygen (mg/l);
- pH (pH units)
- Turbidity (NTU).

In deep water, it is preferable to use a mounted rosette, with multiple probes measuring continuous data and relaying it directly to a shipboard computer. The rosette, with CTD (device for measuring depth, salinity and temperature), fluorometer (for measuring fluorescence and used to infer phytoplankton concentrations), and probes for measuring dissolves oxygen can be mounted with Niskin bottles for collecting water samples and specific depths. These depths can be pre-planned, or determined as per changes in the salinity and temperature as seen on the CTD results. When using this method, water samples should always be collected on the return journey i.e. once the rosette has travelled to its lowest depth and is on its way back to the surface. This ensures water from shallower depths is not caught within the Niskin bottles. Alternatively, a “cheap and cheerful” method of acquiring multiple samples on a single equipment deployment, a string of NISKIN sample bottles can be used in the place of a rosette.

The manufacturer’s instruction manual shall be the primary reference source for information relating to calibration, operation and maintenance of the field probes. Records must be kept of all activities

undertaken on the probe (use, calibration, maintenance, etc.) to demonstrate compliance with the manufacturer recommendations and to allow subsequent auditing to be undertaken.

When in use during fieldwork activities, the probe shall be washed with distilled water in between sample locations and stored as per the manufacturer instructions. Where distilled water is not readily available, tap water may be used if this is stated in the manufacturer's equipment manual as acceptable. Additionally, a log must be maintained of all instrument calibrations detailing the date, time and results of the calibration (as per manufacturers recommendations). Additionally, the field notes will record additional data at the start of the programme detailing the instrument serial number, the calibration standards that have been taken on the survey and their expiry date.

The tolerance range of a calibration against standard solutions should be no more than 5-10%. The meter must be re-calibrated and/or calibration checks undertaken on a routine basis throughout survey operations to ensure the probe is functioning correctly and that the instrument has not 'drifted' or that the probe has not become damaged. Typically, the instrument should be calibrated at the start of each day's fieldwork and a number of checks undertaken during the course of the day. A final calibration check is carried out on completion of the day's activities.

Maintenance of the field probe shall follow the manufacturer's recommendations and shall be documented in both the field notes (during fieldwork) and the equipment maintenance records (at the equipment storage base). This is to ensure there is a comprehensive record of all activities undertaken on the probe for audit purposes. Typical maintenance activities may include daily sensor cleaning/wiping or monthly pH probe changes, etc.

Factory calibrations will always be more accurate than field calibrations. Sensors on the profiler/probe should be tested at the start of the field work and then at regular intervals but only field-calibrated if there is a noticeable slip in accuracy. Certain sensors will require regular calibration though (e.g. Valeport 606+ DO probe needs to be calibrated about once a week due to chemical degradation of the sensor)

In addition to the above, the following should be noted during operation of field probes:

- For seawater of unusual salinity precautions may be required dependant on the field probe model being used. In such circumstances, the meter should be set as per manufacturer recommendations. Other field probes have automatic salinity compensation and therefore no special precautions are required.
- The meter is a delicate instrument and should be handled/deployed accordingly.
- Dissolved Oxygen probes contain a strong alkaline solution therefore care should be exercised when handling.
- To get a uniform reading, slowly move the probe up and down to circulate water through it.
- Clean the probe heads before and after storage, and between samples with distilled water. In the event that distilled water is not available, tap water can be used where this is stated as acceptable in the manufacturer's manual.

- The pH sensor must always be kept moist – storage (short and long term) should be consistent with manufacturer recommendations.
- Where the instrument does not stabilise either during calibration or during a calibration check, the probe that is affected shall not be used to collect further readings until it can be stabilised again.

8.3. QA/QC Sampling

The purpose of QA/QC sampling and testing is to provide the means to assess laboratory precision, the effectiveness of field decontamination procedures and sampling methodologies. Labs in the UK are routinely certified to ISO 17025, a number of international labs also work to this standard.

A number of the types of QA/QC testing described in ISO 5667-14:1998 – Water Quality – Sampling – Part 14: Guidance on quality assurance of environmental water sampling and handling shall be incorporated into Survey programmes. These tests are described in the sub-sections below and shall be used routinely and as appropriate for all field survey works.

Blind duplicate samples: are a means of testing analytical precision. These consist of a duplicate sample which is labelled 'blind' so that the analysing laboratory is not aware that the sample is a duplicate of an existing sample. Typically, a fictitious sample nomenclature is used which is consistent with the survey program so that the laboratory is not alarmed to the fact that a duplicate sample is being submitted for analysis. Collection of blind duplicate samples is a relatively straightforward exercise, with a second set of sample bottles being filled for 1 in 20 (5%) of the sample locations. In a programme where less than 20 locations are sampled, at least one blind duplicate sample must be collected.

This method of laboratory assessment tests the ability of the laboratory to prepare and analyse the same sample and yield results that are within an accepted range of each other. This is a measure of 'laboratory precision' or the repeatability, i.e. the ability of the laboratory to appropriately prepare and analyse samples in a consistent manner. This method does not assess laboratory accuracy.

Typically, this form of testing is normally undertaken on water samples (sea or surface water samples) which have a good level of homogeneity. Soil or sediment samples are not ideal for this activity because of the inherent heterogeneity of the matrix. Whilst it is acknowledged that soil or sediment samples can be homogenised by mixing the sample, such activities can lead to excessive sample disturbance and agitation and are not appropriate where laboratory analysis for volatile or semi-volatile organic compounds is required. Blind duplicate sampling of soil and sediment should only be undertaken where there are no water samples being submitted to the analysing laboratory. Each of the laboratories being used to test samples for a survey programme must be tested where possible. The necessity of duplicate sampling of the sediments and soil and number of appropriate samples should be agreed before the commencement of fieldworks.

Rinseate samples: are used to assess the effectiveness of field or laboratory decontamination/cleaning procedures. Following de-contamination of a piece of equipment, the item is filled with de-ionised water (laboratory grade) and the water is decanted into sample containers (as carefully as possible to minimise agitation) for laboratory testing. In the case of pre-prepared sample containers (from a

laboratory), a rinse water sample can be taken from one of the containers to evaluate decontamination procedures in the laboratory. The purpose of the exercise is to ensure that the sampling equipment does not transfer any contaminants to samples following the decontamination procedure. Laboratory analysis should be undertaken for a relatively wide range of analytes, consistent with the survey programme.

Quality acceptance criteria need to be evaluated within the context of the survey program and the samples submitted, but in general the rinseate analytical data should be below the limit of detection/limit of reporting for each of the analytes tested.

Only one rinseate sample is required for each field survey and is only necessary where non-disposable equipment is used that requires de-contamination between sample locations.

Fuel Sample Test: - for offshore surveys, a sample of survey vessel fuel shall be collected and submitted for fingerprint analysis. In the event that hydrocarbons are detected in water samples, it is prudent to compare the data from the water samples to samples of fuel from the vessel to identify whether the vessel has leaked or spilled any fuel during the course of the sampling.

Sampling of each batch of fuel used throughout the course of fieldworks must be undertaken.

Field blank samples: typically consist of soil or water samples from known uncontaminated areas, but may not be relevant for surveys concerned with Baseline, background conditions.

Spiked samples: are normally prepared by the analysing laboratory. This will not be necessary during Baseline surveys.

Field Spiked Samples: are normally undertaken on water samples where good sample homogeneity can be achieved; samples are spiked with a known concentration of a contaminant.

Split Sampling: is similar to blind duplicate, but the second sample is submitted to a different laboratory to assess the performance of the primary analysing laboratory.

Trip Blank Samples: are samples that are taken into the field with the laboratory bottles (normally sample containers with laboratory grade de-ionised water) and remain with all the sample vessels until the time when they are returned to the laboratory. The purpose of the exercise is to validate the cleanliness of the sample containers and/or to establish whether any contamination of the samples or sample containers may have occurred through storage, handling and transport during field activities.

It should be noted that fish assemblage data (species identification, enumeration, biomass, and length) are significantly influenced by the collection methods. Therefore strict adherence to prescribed sampling protocols is critical. In the case of trawling, fish catches are influenced by gear type and deployment, tow duration, and towing speed. All parties collecting samples in the field must use standard nets and follow standard trawling procedures to ensure that comparable samples are collected. A combination of towing speed and duration along with an estimate of the width of the net mouth during the tow is the only way to estimate the area of bottom sampled. A record of the towing speed and duration must be kept.

8.4. Sample Containers, Storage and Transportation

To ensure samples are handled appropriately after collection the recommendations in a number of ISO guidelines for sample container arrangements, sample preservation, storage conditions and holding times have been adopted.

Sample Containers and Storage

Environmental samples are susceptible to changes as a result of physical, chemical or biological reactions which may take place between the time of sampling and the commencement of analysis. The nature and rate of these reactions are often such that, if precautions are not taken during containment, transport and storage the concentrations of some determinands may be different to those existing at the time of sampling. The extent of these changes is dependent on the chemical and biological nature of the sample, its temperature, its exposure to light, the nature of the container in which it is placed, the time between sampling and analysis, and the conditions to which it is subjected, for example agitation during transport.

Samples must be cooled and stored immediately after collection at temperatures below 5°C (but not lower than 0°C) as this helps to slow down any change or deterioration of the sample. Where it is considered possible that hydrolysis, oxidation, enzymatic and microbial degradation may not be sufficiently suppressed at temperatures between 0 and 5°C, then storage at less than –25°C should be used (as recommended in ISO guidelines), including during transportation, where this is practicable. It is recognised that a storage temperature of –25°C may not always be achievable, therefore samples should be stored as cold as possible and records of storage temperatures maintained.

ISO guidelines and recommendations are provided in detail in the Annexes of this document, briefly they are as follows:

- Sediment/Soil Sample Containers/Preservation/Storage Conditions: taken from the recommendations in ISO 5667-15 – Water Quality – Sampling – Part 15: Guidance on the Preservation and Handling of Sludge and Sediment Samples. The recommendations in this table shall apply to both soil and sediment samples. A summary of the recommended containers is provided in Annex C.
- Water Sample Containers/Volume/Preservation/Storage Conditions/Holding Time: taken from the recommendations in ISO 5667-3:2003 – Water Quality – Sampling – Part 3: Guidance on the preservation and handling of water samples. The recommendations in this table shall apply to all water samples. A summary of the recommended containers is provided as Annex D.
- Biological Sample Containers/Preservation/Volume/Holding Time: taken from the recommendations in ISO 5667-3:2003 – Water Quality – Sampling – Part 3: Guidance on the preservation and handling of water samples. The recommendations in this table shall apply to biological samples collected during marine surveys. A summary of the recommended containers is provided as Annex E.

Offshore, samples are typically stored as follows:

- Water samples – chilled to ~4°C (chlorophyll filters can be frozen)
- Sediment hydrocarbon/heavy metal samples – frozen

- Sediment fauna samples – fixed with formaldehyde (formal saline) and stored at room temperature.

Transportation

Adequate arrangements must be made to ensure that samples arrive at the analysing laboratories no more than a few days after sampling – ideally the next day after sampling.

Of primary importance is the requirement to ensure samples are refrigerated from the time of collection and during transit to the analysing laboratories so that sample integrity can be assured. Samples require shipment in cooler boxes with fresh ice packs or by electric refrigeration and must reach the laboratory within the recommended temperature of 4-6°C maximum on arrival. In some circumstances freezing of samples may be appropriate.

At the analysing laboratory, samples shall be transferred to refrigeration units prior to being prepared and analysed. All laboratories are expected to report the temperature of the cooler box on arrival at the laboratory for QA/QC purposes.

Prior planning is required to ensure that samples requiring exportation out of Lebanon are approved for export as early as possible. Similarly, internal transit of samples within Lebanon requires planning prior to commencement of survey operations to ensure smooth running. In the case of sample exportation, this means ensuring the transportation arrangements and any freight restrictions, import permits, customs and excise duties, etc are fully understood and planned before commencement of survey works.

Poor planning is not an excuse for the late arrival of samples at a laboratory.

8.5. Chain of Custody Procedures

A paperwork trail is required to ensure sample integrity during transit. Chain of Custody documents provide a written record of the ownership and responsibility of the samples during sample transit from the time of leaving site until the time when they reach the analysing laboratory.

The chain of custody document should contain the following information:

- Name and address of the analysing laboratory;
- Name and address of the responsible part;
- An inventory of sample containers. Each sample container should have a unique identification, normally in the form of a bottle number. This should be undertaken where the presence of such information does not interfere with normal transportation agent requirements or does not require the need to open sample containers to check contents;
- Sample preservation details where chemicals have been added to samples;
- A schedule of the analysis to be performed on each sample, per container;
- The date and time of collection for each sample; ;
- The survey ID.

One copy of the chain of custody documentation is retained by the field staff following dispatch to the laboratory from the survey location and the remaining copies are enclosed within the sample container. One set of documentation is provided for each sample container.

Seals should be placed on the opening of the sample container to ensure it is not opened during transit where possible. This is typically undertaken where the sample containers leave the responsibility of the survey contractor and is handed over to a transportation/shipping agent.

8.6. Electronic reporting

All field data collected during surveys shall be reported in an electronic format on an agreed template with unique reference codes. This enables importation into data archives.

9. OFFSHORE SAMPLING

The following sections detail the field methodologies that are to be employed during offshore/marine environmental survey activities.

The following activities are described in the sections below.

- General Considerations for Offshore Environmental Surveys
- Vessel Positioning
- Hydro-Meteorological Measurements
- Water depth, transparency measurements and visual observations
- Seawater Sampling
- Sediment Sampling
- Offshore Flora and Fauna Surveys:
    - Aquatic Vegetation
    - Phytoplankton/Zooplankton/Chlorophyll 'A'/Ichthyoplankton
    - Benthos (Macrobenthos and Meiobenthos)
    - Microbiology
    - Fish

9.1. General Considerations for Offshore Environmental Surveys

The following general considerations should be taken in to account for offshore environmental surveys.

- Marine survey operations require the use of a survey vessel which is typically sourced from a third party. Due to high demand, suitable survey vessels are often in short supply, therefore adequate pre-planning is required to ensure appropriate vessels are available and that they are in line with RPS Energy's HSE requirements. This includes the requirement for reliable and suitable amphibian vehicles for nearshore surveys.

- Where shallow water surveys are to be undertaken an appropriate shallow draft vessel will be required.
- There must be a dedicated fridge/freezer on the vessel capable of holding samples collected, prior to dispatch to analysing laboratories.
- A suitable deck space must be available for ichthyologic sampling activities.
- Environmental samples should not be placed in the same fridge/freezer unit as foodstuffs for hygiene reasons. There must be separate refrigeration for samples and food.
- A digital balance used for weighing samples must have current certification and be subjected to annual checks, calibration and certification. A check weight must be provided during the survey duration to allow checks to be made on the accuracy of the balance.

9.2. Vessel Positioning

The aim of vessel positioning at a survey location is to ensure that the vessel is positioned within a maximum of 20m from the 'reference' (i.e. planned/intended) survey location. It is recognised that surveyed locations will never be exactly the same throughout survey programmes, however the tolerance of 20m is considered both acceptable and realistic in terms of vessel positioning practicality. Positioning of the vessel can be hindered by wind, waves and by inaccuracies of the GPS (Global Positioning System). Also the overall manoeuvrability of the vessel and skill of the crew can affect the positioning of the craft.

An alternative method that can be used in shallow water is for the vessel to steer into the wind/current, cut the engines during the deployment/recovery of the equipment and then start up again instead of anchoring. However this method requires relatively shallow water e.g. ≤30m

The downwind area should be clear of obstructions, e.g. oil rigs. The prevailing current directions and strengths should also be taken into account when setting up on location. The vessel propeller should have a cage fitted to it to prevent any deployment equipment getting entangled.

Vessels shall be navigated and positioned using the vessel's GPS (Global Positioning System) units, which shall be operated and controlled by the Ship's Captain or Navigator.

The co-ordinate of the sample location shall be collected directly in the vicinity of the sampling point from the side of the vessel by means of handheld GPS unit and shall be collected by a responsible person from the survey contractor. All co-ordinates shall be recorded and held in WGS 84 decimal degrees (to 5 decimal places).

Usually the vessel is steered into the wind on approach to the sample location, and continues to move across the location. The anchor is dropped and the engines stopped after the vessel has passed the location by several meters and then the vessel is allowed to drift backwards until the target position is reached. At this point the anchor is fixed.

In shallow water vessel engines must be switched off and cannot be used to stabilise the craft as the propellers have the potential to disturb bottom sediments. In very shallow areas it is recommended that the anchor is dropped several metres windward of the sampling station, without crossing it, to allow the vessel to drift to the sampling station without disturbing sediment with the propellers.

During sampling activities, the position of the vessel relative to the intended location, and distance from that point, are monitored by the captain/navigator or by a responsible person from the survey team. The 'field' position of each sample is recorded and if the distance from the 'field' sampling point to the 'reference' station exceeds 20m then the vessel must be repositioned.

9.3. Hydro-meteorological measurements

The following parameters are to be collected during offshore fieldwork activities (the method of acquisition is provided in brackets).

- Wind speed and direction (ship instrumentation)
- Ambient air temperature (ship instrumentation)
- Atmospheric Pressure (ship instrumentation)
- Cloud Cover (visual assessment)
- Wave Height and Direction (recorded in the Beaufort Scale or similar by visual assessment)

The frequency of data collection shall be up to three times each day - typically at commencement of the day's activities, at the close of the day's activities and one other reading in between. Measurements will be collected via a combination of ship's instruments and visual assessment (as shown above). For each measurement collected, the data shall be stored along with the vessel's position and time of recording. The measurements must be taken where a vessel is positioned at one of the sampling stations.

Units of measurement shall follow SI units where possible. For visual assessment recordings of cloud cover, wave height and wave direction, measurements shall be collected by the Captain or 1st Officer to ensure (i) consistency of recordings throughout the survey, and (ii) measurements are collected by appropriately qualified and experienced person.

Prior to each survey the vessel provider should provide confirmation that ship's meteorological instrumentation is within calibration and provide suitable copies of records for retention.

Data of each hydro-meteorological measurement shall be recorded in the field log and included within the field report for each survey.

9.4. Water Depth, Transparency Measurements and Visual Observations

The water depth at each survey location shall be recorded using a calibrated depth sounder. In shallow locations either a measuring stick or tape can be used. Calibration records for the depth sounder must be retained for records purposes. In case of depth sounder failure a lead-line should be available.

A Secchi Disk shall be used to measure water transparency where the depth of water in each survey location permits. A 200mm (8") diameter Secchi Disk is lowered into the water at each survey location until sight is lost and the depth at which this occurs is recorded. Measurements are to be undertaken to the 0.1m. The disk is then slowly raised to the point where it re-appears and the depth recorded again. The mean of these two measures shall be recorded as "Secchi depth." Secchi depth measurements should be undertaken from the shaded side of the vessel. Additionally, the tape which holds the disk must not be stretchable or measurements will become distorted.

Visual observations shall also be made at each location which shall include the following:

- The presence of any floating oil products or surface sheen;
- The presence or accumulation of algae in the area;
- Evidence, if any, of increased water turbidity;
- The presence of any foam or other products on the sea surface.

9.5. Seawater Sampling

The following seawater sampling procedure is consistent with the considerations outlined in ISO 5667-9:1992 Water Quality – Sampling – Part 9: Guidance on sampling from marine waters and ISO 5667-2:1991 – Water Quality – Sampling – Part 2: Guidance on sampling techniques.

Seawater samples for laboratory analyses (chemical and biological) are collected using a sampling device capable of being remotely opened at a specified depth below the surface e.g. bathometer. The device shall be fully decontaminated prior to use using the procedure described above.

Where samples require filtering, (as for chlorophyll samples) typically through a 45µm filter, one-use disposable devices are favoured as the potential for cross-contamination is minimised.

All chemistry samples pian shall be filtered on-site using a 45µm filter. Due to the high variability of turbidity conditions sample filtration shall be used as a means of standardising samples. Filtration is not required on seawater samples undergoing field probe measurements – only those destined for laboratory analysis.

Care shall be taken to minimise the agitation of the sample as much as possible. Sample containers shall be completely filled to minimise the headspace unless they are to be frozen for transportation purposes. Where freezing is planned, a small headspace must be left for expansion of the bottle to occur.

Sample containers, preservation and holding times shall be as recommended in the Table provided as Annex D.

9.6. Sediment Sampling

The method and approach described below is consistent with the general requirements considerations described in ISO 5667-19:2004 – Water Quality – Sampling – Part 19: Guidance on sampling of marine sediments.

Whilst there are a number of techniques for the collection of sediment samples, Grab Samplers are usually employed in the collection of sediments for chemical, physical and biological analysis. Alternative methods may be used in shallow waters with dense vegetation on the seabed, etc.

In shallow waters a Petersen grab is typically used, and in deeper waters a Van Veenhapper ("van veen") grab is used. The Petersen grab covers an area of 0.025m^2 and the Van Veen grab covers 0.1m^2. The Van Veen grab can be fitted with an internal grid, to further segregate the sample collected. Where a grip is used it is usual to discount the outer edge samples i.e. only consider those collected from the central section of the grid during analyses. A core sampler may be used in areas that are difficult to sample using the above methods, such as reed bed areas. The dimensions of the sampler are optional, however, details of the sampling device (dimensions, etc.) must be provided with sampling information.

Sediment sampling in deeper water should consider the use of a box corer, either 0.1 or 0.25m2. The sample retention rates when using these larger sampling devices in deep water is usually excellent. The use of a 0.25m2 box corer also allows the collection of multiple samples from a single deployment, although this does lead to pseudo-replication of samples with regard to statistical analysis.

Sample acceptance criteria may need to include biological entities such as hagfish that are capable of producing large quantities of mucus.

The surface of ALL sampling equipment must be clean and free of rust.

Sample containers, preservation method, storage conditions and storage duration for all sediment samples collected are detailed in Annex C.

Grab Sampling and Sub-sampling

When the Grab is retrieved the acceptability of the sample must be determined, based on sample condition and depth of penetration.

Sample condition is judged using criteria for surface disturbance, namely leakage, canting, and washing. Acceptable sample conditions are characterised by an even surface with minimal surface disturbance and little or no leakage of the overlying water. Heavily canted samples are unacceptable, so are samples with a large amount of "humping" along the midline of the grab which indicates washing of the sample

during retrieval. While some humping will be evident in samples from firm bottoms where penetration has been poor, this is due to the closing action of the grab and is not evidence of unacceptable washing.

If the sample condition is acceptable, the overlying water is drained off prior to the depth of penetration being determined. Extra caution should be taken to drain the overlying water from the grabs for chemistry and toxicity samples. It is recommended that siphoning or decanting be employed for these grabs to avoid disturbance and loss of the surface sediments. It is important to get the best sample possible.

For infaunal samples, sediment penetration depth must be at least 5 cm; however, penetration depths of 7-10 cm should be obtainable in silt (fine sand to clay). The depth of penetration is determined by insertion of a plastic ruler vertically along the grab midline and measurement of the depth of sediment to the nearest 0.5 cm. During collection, care should be taken to avoid collecting material from the edge of the grab and to use only samples that show undisturbed sediment

Description of sediments is required following measurement of penetration depth. At minimum the sediment should be characterized as being shell hash, gravel, sand, or mud (silt and/or clay). The presence of petroleum tar should also be recorded as well as any obvious odours, such as sulphide (the odour of H2S or rotten eggs), oily (the odour of petroleum tar), or humic (a musty, organic odour). Typically, sediments will have no particular odour. Sediment colours (e.g. black, green, brown, red, yellow) should also be recorded.

When the sample is shown to be acceptable, the first grabs collected at a site should be used for the benthic infaunal sample. For environmental marine surveys three sediment grab samples are required at each survey location; two for benthic samples (described as replicate A and B), and the third grab- for chemistry and toxicity samples.

The following considerations shall be noted when undertaking sediment grab sampling:

- Always keep vertical position of the sling and ensure slow setting of the instrument on the bottom without any inclinations when lowering an open grab.
- Reject grab samples that are too small for representative biological or chemical samples.
- Reject grab samples that have extensive surface ‘washed-out’ due to leakage from jaws.
- Take surface (0-2 cm) samples for chemical/physical analysis using scoops.
- Avoid water dripping into open ‘top’ doors of grab whilst taking samples as it may have hydrocarbon contamination from greased pulleys, wire etc. Similarly minimise possibility of external contamination of sample containers from this source or obvious deck contamination.
- Avoid taking grab samples through surface oil sheens from vessel bilge.

- Wash out grabs between samples/sites using a seawater hose. If oil contamination of grab is evident then wash with solvent and rinse prior to taking the next sample.
- Clean metal scoops between grab samples/sites using the procedure described above.
- Where plastic scoops are used, discard each scoop after use at a sample location. The plastic scoops should not be re-used.

Samples for Chemical/Physical Analysis

- Hydrocarbon sampling from the top 0-2cm of sediment is taken using a metal (stainless steel) scoop, scraped from one quarter of the surface. Note that the one hydrocarbon sample is adequate for aliphatic and aromatic hydrocarbon determination (typically 200-250g wet weight required).
- Heavy metals sampling is undertaken from the top 0-2cm of sediment using a disposable plastic scoop, which is scraped from one quarter of new surface (approximately 200-250g wet weight is required) placed in small self-seal plastic bag and double-wrapped using another bag.
- Phenols sampling - as per heavy metal samples above.
- Granulometric/Particle Size Analysis and organic matter samples are to be taken using the plastic scoop used for metal/phenol sampling by scraping the remainder of surface sediment (approximately 200-300g wet weight).
- Field personnel must be thoroughly trained to recognise and avoid potential sources of contamination of chemistry samples e.g. engine exhaust, winch wires, deck surfaces, ice used for cooling.
- Grabs for sediment chemistry samples must be of similar sediment type and have similar penetration as the grab used for the infaunal sample. This is to ensure an adequate volume of surface sediments for subsampling, and that the chemistry samples come from sediments of similar character as the infaunal sample. Optionally, double Van Veen grabs can be used to simultaneously collect sediment samples from the same site for chemistry and benthic analyses.
- The use of a Munsell colour chart could help standardise the recording of sediment colour across the different surveys.
- Samplers and utensils that come in direct contact with the chemistry samples should be made of non-contaminating materials e.g. plastic, glass, high quality stainless steel, and/or Teflon, and should be thoroughly cleaned between sampling stations.
- Chemistry sample containers must be of the recommended type (see Appendix C) and must be free of contaminants i.e. carefully pre-cleaned.
- Phenols are hydrocarbons and should be stored in either metal tins (or glass/ceramic containers). The sub-sample should be acquired using a clean metal scoop.
- Glass containers should be avoided wherever possible due to their fragile nature, this is relatively unavoidable with certain water samples. However with sediment samples, small metal tins can cope with more damage during transit to analytical laboratories etc.

Redox Potential

Redox potential measurements of sediments are to taken in the field with a portable meter, usually a Portamess pH meter with Thermorussel redox/ORP electrodes.

Measurements are taken from the grab sample at 1cm and 4 cm depths in surface samples with excess seawater drained. Readings are taken after a set time period after the probe is inserted i.e. 20 seconds. It should be noted that redox readings are temperature dependant and as such, temperature measurements of the sample must also be collected – this should be undertaken regardless of whether the redox meter undertakes automatic temperature conversion.

9.7. Offshore Flora And Fauna Surveys

Aquatic Vegetation Sampling

The purpose of aquatic vegetation sampling is to target macrophytes.

The primary method for collecting data on aquatic vegetation species is through transect sampling, i.e. trawling along set routes to collect samples. During trawling activities, the speed of the vessel and travel time shall be recorded. This should normally be in 10 minute durations. The vegetation mass caught by trawl is sorted by species, weighed, air-dried and weighed again. Vegetation mass is calculated in equivalent grams per square metre based on the total area sampled (distance covered multiplied by trawl width).

Description of the aquatic vegetation communities, based on the results of sampling, shall include:

- general condition of the phytocenosis,
- phytocenosis growth characteristics
- species composition,
- abundance of species,
- spatial distribution (homogenous, spotted, group, etc.),
- vertical distribution,
- projected cover (common for all plants and each individual species),
- depth (near upper and lower boundary, if they are different);
- water temperature, near bottom and surface,
- properties of the bottom sediments
- analytical results of laboratory analysis for chemical constituents.

Phytoplankton & Zooplankton

The purpose of phytoplankton and zooplankton sampling is to provide data on the species composition and numbers of species; communities; biomass of main species and groups; estimates of total biomass; composition of dominants; distribution of phytoplankton; and Diversity indexes (e.g. Dominance, Equitability, Margalef, Shannon-Wiever).

The methods provided below are consistent with the general requirements described in ISO 5667-2:1991 – Water Quality – Sampling – Part 2: Guidance on sampling techniques.

Phytoplankton is assessed in a composite water sample of 1 litre. Water samples are collected using remotely triggered plastic collection bottles (such as Niskin bottles) at 1 metre intervals from the triple transparency depth upwards towards the surface. The triple transparency depth is defined as three times the transparency depth (as measured by the Secchi disk and described in Section 9.4.). Bottles should remain open until sample is taken and top / bottle plugs are remotely closed, allowing water to flush through the bottles prior to sampling. A mixed and integrated sample is taken from the volume of water collected.

Water sample volume, 1litre, is fixed with 50 ml of 40% formalin ready for dispatch to the analysing laboratory (see Annex E). The ratio of formalin to sampled water should be used to make an equivalent 2% formalin solution. In freezing conditions up to 96% alcohol can be used to fix samples at up to 70% concentration.

Because of the nature of plankton sampling, samples are unlikely to suffer from cross-contamination from other sample locations (unlike chemical samples which require de-contamination to ensure low-level cross-contamination is minimised), therefore, there is no need to follow the decontamination procedures when sampling for plankton. The sampling vessel (with open valve) must be rinsed three times with seawater at the sample location prior to collection.

Zooplankton from depths of more than 2 metres are caught by Jedie net, which is taken from the entire depth of the water column (two sweeps are undertaken). The Jedie net shall comprise a mesh # 55 net (i.e. 55 threads per centimetre – as per soviet numeration) which is the most efficient for mesoplankton, and have an opening of 12cm. Waters with plankton organisms that wash through the net during each sweep are captured in the metal or plastic collection vessel attached to the bottom of the net. The collection vessel shall have a spout that can be closed by latch.

Before sampling, the Jedie net should be washed out (with open valve) to ensure there are no plankton organisms contained in the net. During sampling the upper ring is lowered to approximately 10-20 cm above the seabed (to avoid sediment disturbance) and the net pulled upwards through the water column. Net retrieval should not exceed 1m per second. Where strong winds or currents are observed a weight can be added to the bottom of the net in order to maintain a vertical sampling movement as much as possible. If it is not feasible to sample in a vertical sweep, sampling can be undertaken from the leeward side. Such deviations to the standard sampling scope must be documented in the field notes.

After retrieval of the net onto the vessel the net should be held in vertical position for a while to allow all water to collect to the bottom into the collection vessel. The sample is then transferred into the sample container. Care must be taken to ensure as much of the sample is transferred from the

collection vessel into the sample container. The net is then rinsed by lowering into the sea again – but ensuring that the upper ring does not go underwater – to allow as much of the sample as possible to drain downwards from the net into the sample container. The water collected in the collection vessel is also transferred into the sample container. The second sweep is undertaken by repeating the above procedure. At the end of each sampling activity at each station, the sample container should hold a composite sample consisting of 4 collection vessel volumes – two sample volumes (net sweeps) and two net washes.

An Apstein net, filtering 50-100 litres of water, is used for depths of less than 2 metres. The Apstein net is also used at deeper depths where qualitative clarification of species composition is required.

There is a standard mesh size/net dimensions that is often used use: 120µm mesh size, 50cm mouth, 1.5m length. There is also an analogue flow meter in the middle of the opening to record water volume as it passes through the net. There is a cod-end at the end of the net that collects the sample.

Horizontal trawls through the surface waters are also now becoming more common.

At new baseline survey stations, one or two additional samples may be taken for qualitative analysis using a net with smaller mesh size # 70, i.e. 70 threads per centimetre, capable of catching the fresh water complex, including small Rotatoria.

Zooplankton samples are fixed in 40% formalin solution with the ratio of formalin 1:9, to make an equivalent 4% formalin solution in sampled water (see Annex E).

Care shall be taken to minimise the agitation of the sample and damage of plankton organisms as much as possible. Sample bottles shall be completely filled to minimise the headspace. If after conservation sample volume is not sufficient, bottles should be filled with additional 4% formalin solution.

Chlorophyll 'A' Sampling

Sampling for Chlorophyll A is undertaken by collection of a 1 litre composite seawater sample. The methodology for collection of this sample the same as that for Phytoplankton sampling. There are two types of Chlorophyll sample:

- In Vivo (field tested sample)
- In Vitro (laboratory analysed sample).

In Vivo Chlorophyll - the Chlorophyll sample shall be tested in the field using a fluorometer. Operation and maintenance of the fluorometer shall be as per manufacturers recommendations.

In Vitro Chlorophyll - the 1 litre sample of seawater shall be filtered in the field onto a membrane glass filter GF (GF/F) with pore size 0.7µm. The filter is stored in a Petri dish which is in turn wrapped in

aluminium foil and the filter sample is frozen ready for transportation to the analysing laboratory. Laboratory analysis must be undertaken following US EPA Procedure 445.

Ichthyoplankton Sampling

Ichthyoplankton are sampled using a net or nets that are towed behind the vessel or motorboat at relatively slow speeds (1-2metres per second or approximately 3-4 knots).

The ichthyoplankton sampling net is made of a mesh # 9-11 nets (i.e. 9-11 threads per centimetre). The dimensions and subsequent mouth opening of the nets must be recorded with the sample notes. However, a typical net should be approximately 0.5 x 0.5m opening. The length of the net shall typically be 2 to 2.5m long, although this can be altered. At the end of the net is a codend bucket or similar that will collect the sample, with a nominal volume of 0.5-0.8 litres.

The length of wire/rope used to tow the net(s) should be no less than 10-15m, potentially longer where bottom towing is necessary. Care should be taken to ensure the mouth opening is underwater when nets are being towed by vessel or motorboat. Each tow shall be undertaken for 10 minutes co-ordinates and time records taken of the start point and end point, collected with handheld with GPS, and duration noted so that the volume of water that has been sampled through the net can be calculated. The trawling speed shall be recorded three times: at the beginning, in the middle and at the end of the trawl. In exceptional circumstances it may not be possible to trawl in a straight line (obstructions such as offshore islands, etc.), and completing a trawl in a circular pattern is allowed. However, this must be recorded in field notation.

The nets can be dragged at the surface (or just below surface) or can be weighted and dragged on, or close to, the seabed dependant on the type of fish species to be sampled. Placement of nets will be depend on length and angle of the wire.

On retrieval from the net, samples are preserved in either 5% seawater formaldehyde (buffered) or 95 percent ethanol. Care must be taken to rinse the codend bucket/sampler vessel as efficiently as possible to transfer as much of the sample over to the sampler container. The sample container must be filled as much as possible to prevent larvae from sticking to the inside of the container and drying out.

If other large plankton organisms eg jellyfish are captured in the net they should also be recorded. These species shall be fixed in a separate sample container. It is recommended that the sample is placed in a relaxant, such $MgSO_4$ (Epsom salts) or propylene phenoxytol, prior to fixation. The sample is left in the relaxant for 30 minutes, after which it should be topped off with a quantity of sodium borate buffered

formalin (which is 37% formaldehyde solution) solution adequate to achieve an approximately 10% formalin solution.

Macrobenthos Sampling

The industry standard around the world in water up to around 250m is the 0.1m2 Day grab (sediment type permitting). Benthos samples can be collected by van Veen grab (deeper water) or Petersen grab (shallow water). A toothed/serrated edge grab sampler may also be used in shallow water areas such as the transition zone where it is impractical to use a Petersen grab. The surface (5cm minimum depth) sediment and overlying water is sampled, using the method described above for sampling. Effort must be made to obtain a minimum sediment volume of 5 litres.

The recovered grab is transferred to a large-capacity tub to capture all water drained from the grab, the grab sample, and the wash water. If the sample volume is adequate, i.e. greater than or equal to 5 litres, the entire sample is transferred to a wash table for screening.

On the washing table the sample is washed through one or more 0.5mm sieves using a low pressure seawater hose. Care must be taken to avoid damage to specimens through excessive force during the sieving process, specifically by minimising the use of hands.

All wash waters used on the sample are to be filtered in some fashion to preclude the accidental introduction of surface-water organisms. Two methods that may be used are an in-line filter in the boat's sea-water pumping system, or the fitting of all wash hoses with fan nozzles having apertures <0.5 mm diameter. Either of these or other approaches that accomplish the same end may be employed.

A Wilson Auto-Siever can assist in the sample washing phase; this piece of equipment uses jets of seawater from the underside of the sieve to wash the sample through. This method means that you do not need fit sieves/filter/mesh to the vessel seawater systems.

The sample container should be filled to approximately 40% of capacity with screened material. Where large samples are encountered it is acceptable to spread the sample over more than one container. A container generally should never be filled with screen material above 50% of its capacity. After the bulk of material has been transferred to the container, the screen should be closely examined for any organisms caught in the mesh. Any organisms should be removed with forceps and added to the sample container. The sieves should be thoroughly washed and the mesh scrubbed with a stiff brush before the next sample is screened.

It is recommended that the sample is placed in a relaxant, such $MgSO_4$ (Epsom salts) or propylene phenoxytol, prior to fixation.

If Epsom salts are used, 1 kg $MgSO_4$ per 20 litres of seawater is added to the sample until the sample container is filled to 85 to 90% of its volume. The container is then closed and inverted several times to distribute the solution. The volume of relaxant used to fill the container should be noted as it will serve as diluent water for the fixative. The sample is then left in the relaxant for 30 minutes. The container should then be topped off with a quantity of sodium borate buffered formalin (which is 37% formaldehyde solution) solution adequate to achieve an approximately 10% formalin solution. Buffered

formalin is made by mixing 50g $Na_2B_4O_7$ (sodium borate) per litre of formalin. The container is then closed, inverted several times to assure mixing, and stored for return to the laboratory.

Alternatively, borax buffered formal saline can be used to fix only macrofauna samples. The formaldehyde was shipped out to the vessel in 5L drums of 40% which was then diluted offshore down to around 10% using seawater from the vessel fire pumps. This 10% solution was then added to the sieved sample along with seawater until the sediment was just covered. The sample container was then inverted several times to ensure a thorough mixing of the sediments.

Propylene phenoxytol may also be used as a relaxant in a solution of 30 ml to 20 L of seawater. The propylene phenoxytol solution can serve as diluent water for the fixative. In this case, after 30 min the container should be topped off with a quantity of sodium borate buffered formalin (which is 37% formaldehyde solution) solution adequate to achieve an approximately 10% formalin solution. Alternatively, after exposure of the sample material to the relaxant for 30 min, the solution may be decanted off the sample through a screen with a mesh size of 1.0 mm or less before adding fixative. Thus, 10% buffered formalin is added rather than undiluted formalin. Any organisms or debris captured on the screen during decanting must be returned to the sample.

In the event that a relaxant is not used on the sample, preservation is undertaken by adding a mixture of approximately 4% formaldehyde in seawater. This is achieved by doubling the volume of liquid in the sample with an 8% formaldehyde solution which is prepared in 10-litre quantities by diluting 40% formaldehyde with seawater (with the ratio 1part of formalin to 4 part of water). Dye (Rose Bengal or Eosin) is added to this 8% formaldehyde in sea water solution to get an intense rose colour.

See Annex E for a summary of the preservation of biological samples from marine surveys. There has been some discussion regarding the benefits of formaldehyde vs alcohol. Formaldehyde is currently supported as in addition to preserving the sample, it also hardens the organisms making them less susceptible to damage in transit.

Personal Protective Equipment (PPE) must be used when handling all chemicals in either the relaxant or preservation stage. This consists of protective gloves, safety glasses and a respirator where undertaken in a poorly ventilated area, i.e. inside. Details of this activity should be provided in the risk assessments for each field activity which will be provided in the Health and Safety work plan prior to commencement of fieldworks.

The following points summarise the key issues to consider when collecting sediment benthic samples.

- Prior to each deployment, the interior of the grab must be thoroughly washed to remove any sediment from the previous sample.
- During retrieval, the grab should be recovered as quickly as is safely possible when it nears the surface. A grab suspended just below the surface is subject to washing as the boat rolls in the sea.
- When washing and screening infaunal samples, gentle water pressure should be employed to avoid damaging the organisms.
- The screen must be thoroughly washed and scrubbed between samples.

- A relaxant is recommended for use on all infaunal samples to minimise fragmentation during fixation.
- The infaunal sample container should be filled no more than 50% full of screening material. After adding relaxant and fixative solutions, the container is to be inverted several times to assure thorough mixing and exposure to relaxant and fixative.
- The handling of infaunal samples on deck should be coordinated so as to ensure that fixative is added at the appropriate time interval (i.e. 30 min) to all samples after exposure to relaxant solution.

Meiobenthos Sampling

Samples for meiobenthos analysis are sub-sampled from the grab sampler (see above for grab sampling methods) using a syringe corer. The top 4-5cm of the core volume is retained as the sample. The diameter of the syringe corer and the depth of core sampled are recorded as part of the sample information.

Three syringe cores are to be taken from each grab sample and homogenised. The homogenised sample from each of the two grab samples shall be designated as replicate A and B.

The samples are preserved in 4% formaldehyde. This is achieved by doubling the volume of liquid in the sample with an 8% formaldehyde. Dye (Rose Bengal or Eosin) is added to this 8% formaldehyde in sea water solution to get a rose colour. However, Not all analytical laboratories require the addition of Rose Bengal to a sample. Some labs discourage its use so it could be worth checking with the analytical lab before staining the sample

Microbiology Sampling

Sediment sub-samples for microbiological analysis are taken from the surface of the grab samples (see above), which are processed for macrozoobenthos analysis. A sterile spoon is used to scrape 20-30 grams of sediment from the surface layer (0-2cm) of the grab sample. This sediment is placed in a labelled, sterile, watertight container with a lid to prevent contamination by air-borne micro-organisms. This container is placed in a refrigerator at between 0 and 4ºC. The sample is kept refrigerated until delivered to the laboratory for analysis (which should be within a maximum 1-2 weeks of sampling).

Fish Sampling

The collection of fish samples shall be undertaken through a combination of trawling and gill nets. These approaches are consistent with the general requirements described in ISO 5667-2:1991 – Water Quality – Sampling – Part 2: Guidance on sampling techniques, however, specific equipment

specifications shall be consistent with those historically used for scientific research purposes within the East Mediterranean area

The purpose of ichthyological sampling is to collect data on the following:

- species composition,
- the presence of commercially valuable
- rare species,
- gender
- age
- distribution
- mass
- size of species
- level of fish tissue/organ contamination.

Fishing activities are strictly controlled by the Lebanese Directorate of Land and Maritime Transport, so relevant permits and permissions for any fishing activities must be obtained prior to commencement of fieldworks.

Any fish caught that are in the IUCN Red Book for the East Mediterranean must be measured (body length) and weighed (using a spring balance for speed) and returned alive to the sea.

Trawling is undertaken by 'big' beam trawl for all sampling locations except those in shallow water areas where a 'small' trawl is permitted, i.e. where it is too shallow for the vessel to tow the standard size trawl.

The 'big' beam trawl shall have the following characteristics: frame height 0.6m, length approximately 2m, bag length 6m, mesh size 10-12mm. The 'small' beam trawl shall have the following characteristics: frame height 0.4 m, length approximately 1m, bag length 4m, mesh size 10-12mm.

The trawling duration will be 5 to 10 minutes depending on sediment characteristics. Trawling speed shall be approximately 1.5-2 m/s (3-4 knots). Records of the start point, mid-point and end point co-ordinates of the trawl shall be taken using GPS and the length of trawling route calculated. Duration shall also be noted so that the seabed area that has been sampled can be calculated. The trawling speed shall be recorded three times: at the beginning, in the middle and at the end.

If the trawl is retrieved with little or no catch, its acceptability will be evaluated according to whether the trawl was conducted properly. A trawl is conducted properly if the correct depth, speed, and distance or duration is maintained, if it is not fouled (net tangled), and if there is some evidence e.g. rocks, benthic invertebrates, benthic fish, that the net was on the bottom. If any of the trawl procedures were not followed, if the net was fouled or torn sufficient to allow escape of samples, or if there was no evidence of contact with the bottom, the trawl will be considered unacceptable. If so, then another trawl will be conducted at that site, if feasible.

The trawl catch should be crudely sorted on deck into containers, typically into major categories. Debris and vegetation should also be noted. For the more detailed sorting activities, all fish will be identified to

species using taxonomic keys and field guides as needed. Species of fish that cannot be identified to species in the field will be returned to the laboratory for further identification. When these have been identified in the laboratory, the correct identity of the species will be recorded on the original data sheet. If the laboratory identity differs from that recorded in the field, the original name should be crossed out with a line. Do not erase the original name. It is important to keep all relevant records in the event of a dispute over species identification.

Under no circumstances should an organism be discarded if the identity is questioned,(either in the field or in the laboratory.

Each trawl catch will be subjected to the following analysis:

- Species identification;
- Total number and weight (mass) of each species in the trawl catch;
- Weight (mass) measurement of all caught fish (measurement of body length without caudal fin)
- For the most numerous species in the catch more detailed bio-analysis is to be undertaken. Up to a maximum of 50 individuals shall be taken and the following measurements made.
    - Total length (L) (total body length);
    - Fork Length (l) (body length without caudal fin);
    - Total Weight (Q);
    - Empty Weight (q) (eviscerated);
    - Sex and stage of maturity.

Species that are not commonly caught in trawl catches (i.e. not demersal) shall not be subjected to detailed analysis but shall undergo simple measurements (species identification, total number and mass of each species and weight of all caught fish).

Where a catch consists of more than 50 individuals, only minimal processing shall be undertaken (i.e. mass measurements) on the individuals have not already been subjected to biological analysis. Where a catch consists of more than 100 individuals, only the first 100 shall be processed using the above approach - the remainder of the catch shall not be processed.

Any sub-sampling procedures undertaken on board the vessel must be random and not subject to any potential bias. Whichever method is chosen the overall purpose must be to ensure that each fish from the catch has an equal chance of being selected for the sub-sample. No preference must be given to “exceptional” fish (i.e. particularly large or small fish) and it must be equally likely that these, as well as the “typical” members will be chosen.

The presence of obvious free-occurring fish parasites, such as leeches or cymothoid isopods will be recorded.

Incompletely identified fish and those with diseases that require further examination should be sent to the laboratory. Fish may be preserved or documented for QC or identification purposes in one of three ways: fixing in buffered formalin-seawater; freezing; or photographing.

The preferred method for smaller specimens is fixing in 10% buffered formalin-seawater. Buffered formalin is made by mixing 5g Na2B4O7 (sodium borate) per litre of 10% formalin. All specimens with tumours, fin erosions, or lesions should be fixed in this manner. Before fixing, the body cavity of fish greater than 60mm should be slit with a scalpel on the right side (for most bilaterally symmetrical fish).The slit allows preservative to enter the body cavity and preserve the internal organs. Fish can be placed in either plastic bags or plastic jars and fixed in 10% buffered formalin-seawater. Fish should be inserted tail-first into jars so that they can be removed easily without destroying the fin rays or spines.

Fish should remain in the formalin solution for up to a week before being rinsed in freshwater. It is recommended that fish specimens be placed in fresh water for at least two days, changing the water at least once during that period. After rinsing in water, the fish should be transferred to 50% isopropanol (isopropyl alcohol) or 70% ethanol for preservation.

Larger specimens can be placed in plastic bags and frozen if sufficiently large containers are not available or if large quantities of fixative are required. These can then be thawed and fixed in the laboratory with 10% buffered-formalin solution. However, it is preferable that large specimens with tumours, fin erosion, or lesions should be fixed in the field with formalin rather than frozen.

Large specimens of fish can be photographed in the field. When photographing fish, bilaterally symmetrical species should be photographed facing left (unless an anomaly occurs on the right side). All specimens should be photographed on a light background with a meter stick alongside and a label giving the date, station number and species in large bold letters. Photographs should show the overall appearance of the specimen and important identifying features, if possible. Note should be made of character states that are crucial for identification purposes (e.g. counts of fin rays, gill rakers, and scales).

Specimens preserved for further identification should be noted on the field data sheet. A note should be made whether the organism is fixed, frozen, or photographed. A log of all organisms photographed should be kept during the survey, recording the frame number, date, location, station, and subject of each photograph.

Gill Nets -shall have nets with mesh sizes of 12, 20, 24, 30, 36, 40, 50, 60, 70, 80, 90, 100, 150, 200 and 250mm deployed overnight (one of each size). Net height will be 3 meters and the overall length of the net will be 25m.

The following are the net standards that are recommended for offshore environmental surveys. Each 1m length of gill net shall consist of a pleated net of 2-2.5m in length. Thread thickness (Tex is a unit of measure for the linear mass density of fibres and is defined as the mass in grams per 1000 metres) is also a consideration and should be specific for each mesh size.

- Mesh size 12-40mm - tex 15.6x3;
- Mesh size 50-90mm - tex 29x3;
- Mesh Size 100-250mm - tex 95.3x3.

Prior to nets being set in the water, preparation must be undertaken to ensure tangled sections are identified and that repairs can be made if necessary. Following inspection the nets must be arranged so that they do not tangle when they are set. This involves ensuring the lower guard rope with net weights and the upper guard rope with floaters will not be in contact. Nets with different size meshes are tied together in a set, from smaller to larger sizes meshes. A signal buoy and anchor holding the nets are tied on to each end of the net set.

Nets are set with the vessel or motorboat at drift if there is a light wind and at slow run of the vessel engine in relatively calm weather. Nets cannot be set in rough weather. To avoid the nets catching on parts of the vessel the nets should be placed in the water inside a canvas cover. The anchor and signal buoy are dropped in the water first and as the anchor tie member becomes tense the nets are placed. In locations with high levels of maritime traffic, signal buoys should be illuminated.

Setting of nets should be undertaken by a minimum of three people – one each controlling the upper and lower guard ropes of the nets, and a third person operating the engine. It is not permitted to set nets at night time.

Nets should not be set in adverse conditions are encountered, Specifically the following guidelines should be followed: for small boats (with oars or small outboard motors) it is not permitted to set nets where wind speeds are above 5m/sec and wave heights above 0.5 m are encountered; for larger vessels it is not permitted to set nets where wind speeds are above 10m/sec and wave heights above 1.5m.

During the removal of nets from the water, the signal buoy and fixing anchor are pulled by a small boat hook, after that the net is collected from water. The net is removed by the first person, the second person assisting and the third operating the vessel/boat by means of the engine/oars. The lower and the upper guard ropes should be removed from the water simultaneously. Larger fish (i.e. greater than 30-40kg) will need to be removed from the water by a pole hook.

The catch should be sorted on deck into plastic containers or bags that are represented each of the different mesh size nets (i.e. 12mm mesh size; 20mm mesh size, etc.). Each container or bag should be clearly labeled. All fish will be identified to species using taxonomic keys and field guides as needed. Species that cannot be identified will be sent to the laboratory for further identification.

The processing of a gill nets catch shall consist of the following records being taken:

- Species Identification
- Total number and mass of each species in each net
- Weight (mass) measurement of all caught fish (body length without caudal fin)
- For the most numerous species in the catch more detailed bio-analysis is to be undertaken. For each species selected the catch shall be grouped into total length size where the size classification interval shall be 1 centimetre intervals. Up to ten specimens of each group shall be selected for more detailed measurement of
    - Total length (L) (total body length);)

- Fork Length (l) (body length without caudal fin);
- Total Weight (Q);
- Empty Weight (q) (eviscerated);
- Sex and stage of maturity
- Age determination – for bony fish this is undertaken by inspection of scales, for sturgeon this is undertaken by inspection of the first ray of the pectoral fin.

Large fish shall not undergo bioanalysis. After the measurements of length are taken the fish are to be released back to the sea.

Toxicology Analysis

Fish organs and tissues from gobies (or other suitable fish species) are analysed for contaminants in the laboratory. After either fish trawling or gill nets sampling, weight (mass) measurements of the largest specimens of gobies are selected.

The number of individuals selected for each type of toxicology testing shall typically be between ten and twenty-five (depending on the size of fish) in order to acquire a sufficient weight (mass) of fish tissue for relevant testing to be undertaken. Where samples are destined for heavy metals analysis, the samples shall be double wrapped in self-seal plastic bags. For hydrocarbons testing fish samples shall be wrapped in aluminium foil (pre-cleaned with methanol or an equivalent laboratory grade solvent) and then in a plastic bag and stored at temperatures of -18°C. All tissue separation shall be undertaken in the laboratory.

Acoustics

Underwater acoustic can be monitored to give an indication of background noise levels. Sound in water is measured using a hydrophone, which is the underwater equivalent of a microphone. The hydrophone measures pressure fluctuations, which are converted to sound pressure level (SPL). SPL is a logarithmic measure of the mean square acoustic pressure.

Acoustic measurements should be taken with the boat engines off. Records should be made of weather conditions, wave height, any passing vessels, and an estimation of distance to shore. These measurements can then be used to interpret variation within the results.

Background noise level must be an average measurement, compiled from a time series of data collection.

Sea Turtles

As sea turtles are endangered, data collection is best completed in a non-invasive way. Primary data collection for sea turtle abundance involves surface watch from a small survey vessel. Consultation with local fishermen can also identify sightings, although species identification should always be verified where practical.

Where appropriate, sea turtle sampling and data collection can be completed using a simple catch and release method. The rodeo method (Ehrhart and Ogren, 1999) entails sighting, pursuing and capturing turtles from a small boat. GPS is used to measure the start and end points to delineate transect length, allowing a calculation of catch-per-unit-effort (CPUE) to be completed. These CPUE measurements are used to quantify abundance, and are largely comparable with other studies.

Once captured, the following data should be collected for each specimen:

- Weight
- Size measurements
- Photographic identification (to build a photo library of individuals and minimise likelihood of repeat sampling)
- Sex

After all measurements have been taken, the turtle should be tagged with appropriate identification then returned to the sea. Time out of water should be no more than 25 minutes. At nesting sites, there is the option to complete all of these measurements on landed females, as well as attaching a tag.

Marine Mammals

Prior to completion of marine mammal field surveys, published data should be reviewed to allow area characterisation to be completed. This will guide expectations of the survey, and help to evolve a suitable survey method for the area. Importantly, marine mammal abundance is likely to change seasonally and annually, therefore temporal and spatial elements need to be worked into the survey programme.

Marine mammal surveys should focus on species present, distribution and abundance. The most basic assessment is a presence / absence survey; where by the sighting of a species is marked as a positive record. Distribution of species can be inferred from this type of survey. In order to estimate absolute abundance, it is necessary to (1) record effort i.e. number of individuals spotted per hour, and (2) estimate the proportion of animals that are missed during the survey transect line.

The visual and acoustic methods described above can be divided into two sampling approaches: Fixed Point Surveys and Transect Surveys:

- Fixed Point Surveys record detections from a fixed point, whether it be a vantage point survey from a headland (point transects) or a POD (a type of autonomous acoustic data logger) on the seabed (point counts). This method is comparatively cheap and non-evasive; however it cannot be used to estimate abundance.
- Transect Surveys are conducted from a moving platform (ship or aircraft) and detections are recorded (visually or acoustically) along a single/set of line transects. Using this method the survey area is pre-defined, and during the survey observers record the perpendicular distance to each of the sightings together with data on the species and group size.

Presence / absence field observations of marine mammals can be collected at all times during sampling. A library of photo identification should be compiled from the onset, to reduce the risk of multiple data entries for the same individual. Transect Surveys should be completed during specific marine mammal survey programmes. Where possible, aerial photo-monitoring gives the best natural coverage of a survey area; allowing an assessment of population size without the need to account for disturbance created by vessel movements or noise levels. Marine mammal observations should be carried out during daylight hours by someone trained in marine mammal spotting (i.e. JNCC marine mammal observation).

Recommendations for ship-based surveys

- Line-transect should have a strip width of 300m maximum.
- Subdivision of survey bands to allow corrections for missed individuals at greater distances away from the vessel.
- No observations in sea state 3 or more to be used in data analysis for marine mammals.
- Survey time intervals are recommended to be 1 or 5 min intervals (range 1-10m, longer time intervals are acceptable when less resolution of data is required; short intervals are preferred in small study areas), with mid-positions (Latitude, Longitude) to be recorded or calculated for each interval.
- Preferred ship's speed should be 10 knots (range 5-15 knots).
- Preferred ship type is a motor vessel with forward viewing height possibilities at 10m above sea level (range 5-25m), not being a commercial or frequently active fishing vessel.
- Preferred ship-size: stable platform, at least 20m total length, max. 100m total length
- Two competent observers are required per observation platform equipped with range-finders (Heinemann 1981), GPS and data sheets; no immediate computerising of data during surveys to maximise attention on the actual detection, identification and recording.
- Observers should have adequate identification skills (i.e. all relevant scarce and common marine species well known, some knowledge of rarities, full understanding of plumages and moults).

Recommended methodology for aerial surveys

For a minimum set-up, the following techniques and qualifications are recommended.

- Twin-engine aircraft (for safety and endurance)
- High-wing aircraft with excellent all round visibility for observers (e.g. twin-engine Partenavia P-68 Observer)
- Line-transect methodology is recommended with sub-bands.
- Transects should be a minimum of 2 km apart to avoid double-counting whilst allowing the densest coverage feasible
- Flight speed preferably 185 km h-1 at 80 m altitude
- Subdivision of survey bands to allow calculations of detection probabilities (recommended are 44-163m, 164-432m, 433-1000m, with a declination in degrees from the horizon being 60-25°, 25-10°, and 10-4° respectively for the Partenavia P-68 at 80m)
- Use of an inclinometer to measure declination from the horizon
- Two trained observers, one covering each side of the aircraft, with all observations recorded continuously on dictaphone
- GPS positions are recorded at least every 5 seconds (computer logs flight track)
- The time of each marine mammals sighting should be recorded, ideally to the nearest second, but within 10 seconds accuracy, using a watch attached to the window of the plane.
- No observations in sea states above 3 (small waves with few whitecaps)

Acoustic monitoring relies upon Passive Acoustics (Passive Acoustic Monitoring (PAM)) to identify cetacean calls in the vicinity of the vessel. This method is more accurate, as the individual does not need to be surfacing during the survey, however only animals which naturally use echolocation (i.e. “call” to identify their position) will be detected. When used in combination with field observations, PAM can be used to verify the species of different sightings.

In addition to the above survey methods, annual monitoring of pinniped beaching sites should be completed to give an indication of relative growth of localised populations.

Marine Birds

As with marine mammals, bird surveys can either be completed from a vessel or from an aircraft. Where possible, it is best to combine data from both types of survey. Data obtained during aerial surveys may be combined with environmental parameters in a correlative approach, whereas the advantage of a ship is that such parameters can often be collected simultaneously. The slower approach with vessels allows detailed observations on seabird behaviour (habitat utilisation, feeding conditions) and diurnal/tidal fluctuations in seabird abundance and distribution.

Recommended methodology for ship-based surveys

Recommended census techniques for ship-based seabird surveys are line-transects with subbands and with snap-shots for flying birds, and incorporating the full behaviour module recording detailed information on species, sex and age where feasible, foraging behaviour, flying height. Whenever possible, hydrographical data, such as sea surface temperature, salinity, water depth should be continuously and synoptically monitored. In addition to those summarised in the section previous, the following techniques and qualifications are recommended.

- No observations in sea state 5 or more to be used in data analysis for seabirds
- Bird detection by naked eye as a default, except in areas with wintering divers Gaviidae. Scanning ahead with binoculars is necessary, for example to detect flushed divers.

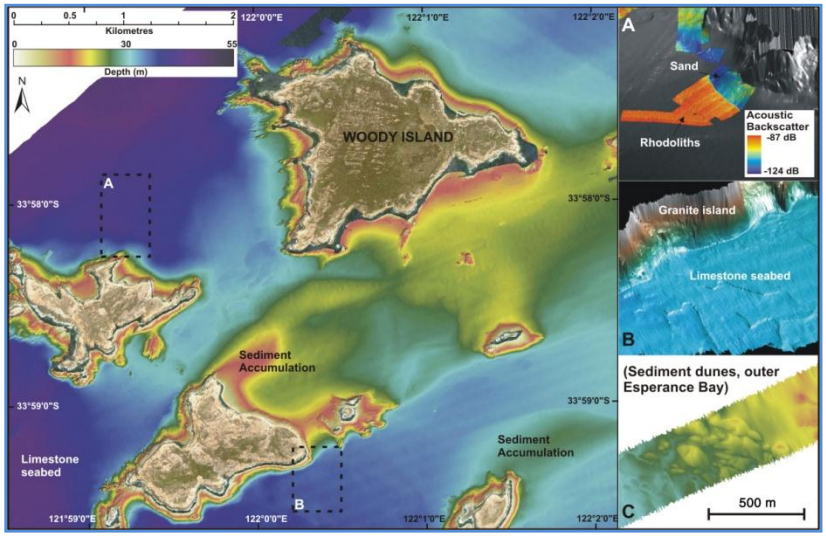
Recommended methodology for aerial surveys

Methodology should be as described in the section previous (marine mammals).

Where possible, combination of marine mammal and seabird surveys is recommended, although additional observers will be required in order to ensure that sufficient watch time is spend on both groups.

Habitat mapping

Habitat maps of the marine environment are required to provide a better understanding of the distribution and extent of marine habitats. Knowledge of the distribution and extent of marine habitats serves to establish sensible approaches to the conservation needs of each habitat and to facilitate better management of the marine environment through an understanding of how particular human activities are undertaken in relation to marine habitats.



Mapping of marine habitats is completed through remote sensing techniques such as multi-beam echo-sounding, side-scan sonar and acoustic ground discrimination, following by ground-truthing techniques such as sediment grabs, camera tows and dredging. Mapping requirements will vary depending upon habitat being studied i.e. the techniques used for open ocean vary considerably to those

used in a sub-tidal estuary. For the majority of truly offshore areas (i.e. no littoral regions), a survey area should be established within which a number of transects are defined. Vessel methodology should be as follows:

- Measured data should be time and geo-referenced, to allow for any necessary alterations
- Typical offshore survey speed for a generic geophysical site survey (MBES. SSS. HMP etc) is 4 knots. Line spacing typically gathers data with 100% overlap.
- One known interaction is occasionally the HMP and MBES can cause interference on the SSS data which appears as short, thin black lines
- Minimal overlap of survey coverage should be maintained between transects, to ensure that all seabed is covered
- Use of multiple survey methods simultaneously should be appraised to ensure that interactions are not going to produce negative results.

During data collection, the onboard scientist should continuously monitor the equipment outputs to determine any areas of interest / changes in sediment / habitat. Geodata from these locations should be recorded to allow the vessel to revisit and ground-truth the data collected by the sensor. Ground-truthing should be done at all relevant locations, either by sediment grab or by underwater camera.

Full use should be made of GIS capabilities for mapping and data management and manipulation.

10. ONSHORE PHYSICAL ENVIRONMENTAL SURVEYS

10.1. Air Quality Sampling

Air quality sampling can be undertaken both offshore and onshore. The same principles apply in each case. A number of methods can be used for air quality sampling: portable field gas analysers, sorption tube sampling, passive tube sampling, bag sampling, etc.

Passive air diffusion tubes and active filtration units should be used offshore with caution. The vessel will be emitting particulates and gases from the funnel at all times during a survey which will influence the measurements acquired from the equipment.

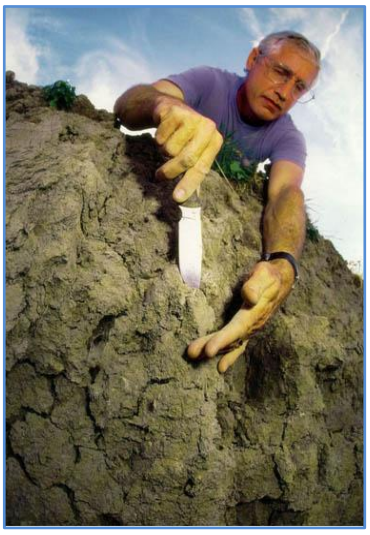
When undertaking any air quality measurements in the field, care must be taken to ensure no possible cross-contamination sources are introduced into the sample such as exhaust emissions from portable power supplies, vehicles or vessel engines, etc.

Portable gas analysers, as all instrumentation, must be certified, have appropriate factory calibration records and be operated and maintained under the guidelines of the manufacturer. The operator of the equipment must carry a maintenance and calibration methodology/specification with the instrumentation during use in the field. All calibration gases must be certified and within expiry date.

Field sampling for laboratory analysis (e.g. sorption tubes, bag samples, filter papers, etc.) must be undertaken in accordance with relevant guidelines and shall be transported in sealed boxes containing activated charcoal in order to avoid any possible ingress of contaminants from the atmosphere (e.g. car exhausts, etc.).

10.2. Soil Sampling

Soil sampling is undertaken in order to obtain a sample that is representative of the conditions in the area of investigation. The purpose of soil sampling is to provide data on the quality and physical characteristics of the soil samples collected.



Soil samples can be collected by a number of methods:

- During drilling of boreholes (either for geotechnical investigation or for groundwater monitoring well installation). Using this technique, either undisturbed soil samples can be collected from core samples, alternatively, some drilling techniques will result in disturbed samples being collected.
- From excavation pits using a mechanical excavator (a disturbed soil sample is collected).
- From hand augering activities (a disturbed soil sample is collected using this method).

- From hand excavated holes (both disturbed and undisturbed soil samples can be collected using this method).

The reader is referred to ISO 10381-2:2002 (Soil Quality – Sampling – Part 2: Guidance on sampling techniques), for a description of all methods available for collecting soil samples and their relative merits.

Composite soil samples may be collected from Environmental Observation Points (EOP's) using a method described as the "envelope" method. A composite soil sample in this case shall consist of five sub-samples – one from each corner and one from the centre of the observation area (usually a 10m x 10m square) and then combined to create one composite sample. No fewer than five sub-samples shall be taken when following the "envelope" method. When undertaking sampling at an EOP, one composite sample is collected from the surface (0-5cm) and another from depths of 5cm to 20cm.

Discrete sampling, i.e. specific to a geological horizon, shall be undertaken where specific particle size testing or chemical testing is required on a specific geological horizon.

When collecting samples from the wall of an excavation, care should be taken to ensure a discrete sample is obtained and there is no 'smearing' from other horizons. The principles described in Section 4.4 shall be followed when selecting a sampling device. Otherwise, samples can be placed by the operator directly into sample vessel where the field operative is wearing latex gloves. The gloves are then discarded following collection of the sample.

Samples to be analysed for volatile or semi-volatile suites must be transferred directly to the sample containers and the sample vessel filled as much as possible with minimum agitation. The headspace at the top of the sample container must be minimised. This reduces the air gap available in the sample vessel for volatile and, to a lesser extent, semi-volatile compounds, to escape from the sample matrix into the headspace.

Samples collected for other suites can be placed into a bowl (made of an appropriate material) and mixed to ensure a homogeneous sample is obtained where this is required, otherwise samples should be placed directly into the sample containers.

All non-disposable sampling equipment (stainless steel trowel, stainless steel bowl, plastic trowel, plastic bowl, etc.) must be fully decontaminated in between sample locations as per the procedure described above.

Container type, preservation method, storage conditions and storage duration shall follow the recommendations detailed in the table in Annex C.

10.3. Soil and Sediment Descriptions

During either borehole drilling or excavations (manual or mechanical) or when collecting sediments a record must be made of the geological horizons and other conditions encountered.

The level of information required during environmental surveys would not be to the same standard as required for geo-technical investigations, however, the aim of the activity is to provide a clear and concise record of the ground conditions encountered at each location to enable a clear picture of the underlying conditions to be acquired.

The type of information that is important when classifying soils and sediments is summarised as the following. These types of information should be included with all geological descriptive text.

- Designation of soil type;
- Grain size (descriptive, i.e. sand, silt, clay or mixture);
- Colour;
- Degree of consolidation;
- Moisture content;
- The presence of organic material (roots, etc.);
- Whether there is any evidence of contamination; and
- Any other relevant observations.

Rock descriptions should also include information on the degree of weathering, the presence of fractures or solution cavities, staining or possible mineralisation along fractures, etc.

For reference, simplified soil descriptions must be consistent with the standards set out in ISO 11259 (1998); Soil Quality – Simplified Soil Description.

10.4. Groundwater Monitoring Well Installation

The general approach to groundwater monitoring well installation described below is consistent with the considerations described in ISO 5667-11:1993 – Water Quality – Sampling – Part 11: Guidance on sampling of groundwaters.

A range of drilling methods are available for drilling boreholes. The method to be used shall be clearly described within the risk assessment and included in the Health and Safety Plan prior to commencement of works.

Wells will typically be drilled at a diameter of at least 147mm (6”), or larger, which will allow a 100mm (4”) diameter piezometer to be installed. This is of sufficient diameter to allow electric submersible pumps to be used for development and purging of wells. Smaller diameter boreholes, with subsequently smaller diameter piezometers, may be drilled where there is appropriate means to remove the required volumes of water from the wells following drilling (before sampling activities commence). The use of degreasants, lubricants, muds, oils and bentonite during drilling activities should be avoided where possible, particularly where sampling for organic compounds.

The generalised well construction for onshore groundwater monitoring wells (permanent and temporary) shall consist of piezometer with a screened/slotted section and a plain section. The screened section of piezometer pipe will have slots no more than 2-3mm width, and will have a gravel filter pack installed around it. Well material should be HDPE where available. The use of uPVC is not recommended for long term monitoring locations. Threaded pipework sections shall be used to connect the well sections, as no solvent based cements or glues must be used on the material.

The filter pack shall consist of fine gravel between 5-10mm particle size – this is to reduce the quantity of fine material that can enter the well. The plain section will have a bentonite seal which will be installed at a height of approximately 0.50m above the screened section (on top of the gravel pack) and will typically be at least 0.50m in thickness. A cement:bentonite grout will be emplaced above the bentonite seal which will be finished to ground level. Care is necessary to ensure that boreholes completed with a gravel pack around a solid casing and screens at specific levels are not subject to short circuiting of surface water/aquifer water from different depths via the gravel pack. To this end, the bentonite seal is required.

The well will be finished at surface with a good quality headworks that will protect the installation. Dependant on the location of the well, the headworks will be either flush with ground level or will consist of an upstand metal tube around the well (with concrete surround). Lockable headworks shall be used at all well locations as this minimises the potential for tampering with well installations (deliberate or accidental). Groundwater monitoring wells shall be clearly marked with the headworks painted in an appropriate colour, the well name/number shall be clearly shown, and the headworks protected from damage with appropriate barriers where there are vehicle movements in the area.

Detailed well construction logs will be required for all locations.

10.5. Water level measurement

Whenever water levels are measured in boreholes, the field operative must aim to obtain accurate measurement of the depth of the water level and the total depth of the borehole. Water level measurement should only be undertaken after a newly installed well has been left for a sufficient period of time to stabilise. This normally occurs after a period of well development which removes any agitated material from the drilling process and allows the well to stabilise within the hydrogeological unit.

A round of water level measurements on an existing network of wells should normally be the first task, prior to any purging or sampling activities. Water level measurements should be undertaken as a single exercise and not undertaken as part of an overall well development/purging programme. This is to ensure that measurements are collected from a network of wells at a time interval as close as possible together. This ‘snapshot’ of data allows the groundwater measurements to be plotted out to determine

groundwater flow direction, etc. and ensures that no external factors (rainfall, etc.) influence the measurements collected. Measurements from a set of wells that are collected over an extensive period of time (days or weeks) does not provide any useful data as water levels are open to fluctuation (however small) over time. Where the distance between boreholes is significant, multiple field teams must be mobilised to collect field readings in the shortest timeframe possible.

- Only clean, decontaminated equipment should be lowered into the well.
- Where a well cover has formed an air tight seal over the piezometer, the well should be left for approximately 30 minutes after removing the seal to allow the water inside the well time to stabilise with atmospheric conditions.
- The survey contractor shall create markings on the piezometers or on the well casing after well installation which will serve as a permanent reference mark for all future well measurements (as well as acting as a survey reference). This is required to ensure that all future measurements are referenced to the same point.
- Appropriate decontamination procedures should be undertaken on any device after being used in a well to ensure that no cross-contamination between locations occurs. Where groundwaters have been demonstrated to be relatively clean and free from contamination, a rinse with distilled water between locations will suffice. However, where known contamination exists, equipment should be thoroughly decontaminated between locations to minimise the potential for cross-contamination.

10.6. Groundwater Sampling

The objective of groundwater sampling is to acquire a representative sample of the hydrogeological unit to enable field testing and laboratory analysis to be performed.

The method described in the paragraphs below is consistent with the general requirements set out in ISO 5667-11:1993 – Water Quality – Sampling – Part 11: Guidance on sampling of groundwaters.

Following completion and installation of a new groundwater monitoring well, the location requires development prior to purging and sampling. Well development consists of removing water from the well to stabilise the well following the disturbance created by drilling activities.

The ‘volume’ of a well is calculated by taking the depth of water present in the well and calculating the volume of water present within the total diameter of the borehole (drilling diameter). This is called ‘one well volume.’

Typically, well development encompasses removal of at least 5-10 well volumes of water from the well to ensure fresh water from the hydrogeological unit is drawn into the installation. However, if water is

added during drilling of the well, then the volume of water added needs to be removed in addition to the development volume. Typically water is added during drilling, dependant on the drilling technique, to assist in recovery of cuttings. Drilling logs should take into account the volume of water used to drill the well. This volume needs to be removed prior to removal of 5-10 well volumes for development.

Well development (and purging) can be undertaken utilising mechanical methods (e.g. down-hole submersible pump), or by manual water removal using a bailer or other similar equipment. Where a submersible down-hole pump is used, a suitable non-return valve must be fitted at the outlet of the pump (prior to the connection to the discharge hose) to ensure pumped water does not drain back into the borehole when the pump is switched off. Whatever method is used, the equipment must be clean prior to lowering into the well so that the potential for cross-contamination between locations is minimised. Following well development, the installation is typically left for a period of 24 hours to stabilise.

Well purging consists of the removal of 3 well volumes prior to sampling the location. This ensures that fresh formation water is drawn into the location prior to sampling. The methods applied to well purging are the same as described for well development above. During well purging, three consecutive sets of readings from the field probe (pH, conductivity, temperature, etc.) must be collected, which must have a relative difference of no more than ±10% of the recorded value. This ensures that stable formation water is being recovered from the installation. Only the final reading from the field probe is reported, although the previous readings must be recorded in the field notebook and retained.

Small non-disposable equipment that is to be lowered into a well can be decontaminated using the methods described above. Submersible pumps must be decontaminated by pumping through tap water with laboratory grade detergent to clean through the pump and discharge hoses, followed by a pump through of tap water to remove any detergent residues. This procedure is normally undertaken by using two tanks (one containing tap water and detergent and one containing only tap water), and recycling the pump discharges around the tank. A clean drum would be suitable for this type of procedure. The outside of the submersible pump can be decontaminated using the procedures described above.

Sampling of boreholes shall be undertaken using a stainless steel bailer or by a dedicated disposable bailer for each location. In the event that a stainless steel bailer is used, then decontamination procedures will need to be undertaken in between sample locations . Single use, or dedicated bailers need not be decontaminated as they will only be used at one location. The bailer must be lowered slowly into the well during sampling to minimise agitation of the sample. Under no circumstances should groundwater sampling be undertaken directly from the pump (unless in extreme circumstances). This causes excessive agitation and will result in a poor quality sample being collected, particularly where volatile and non-volatile organic compounds are to be analysed. Additionally, due to the potential difficulties of de-contaminating the inside of the pump and discharge hoses, the potential for cross-contamination exists whenever a pump is used for sampling.

Samples should be collected in the order of ‘sample sensitivity’ such that volatile and semi-volatile samples are collected first, and then samples which are less affected by agitation are sampled

afterwards. Sample bottles must be filled as far as possible to eliminate any headspace available in the vessel – this is particularly important where samples are to be analysed for volatile or semi-volatile compounds as the presence of a headspace can promote the loss of compounds from the water sample. However, caution must be exercised where glass sample containers are used and are scheduled to be frozen (for transportation purposes) as the jar will be broken as the sample freezes. In this case, a small headspace must be left at the top of the vessel to allow for expansion.

Samples for metals analysis should be filtered in the field through a 45µm filter. This shall be a disposable one-use filter where possible. Re-used filters significantly increase the potential for cross-contamination.

Sample containers, preservation, storage conditions and holdings shall be as detailed in Annex D.

10.7. Surface Water Sampling

For the purpose of this document, surface waters consist of waters from the rivers crossing the coastal plain and any other inland water body (lake, stream, ditch, etc.): it does not include the sea water samples.

The approach to surface water quality sampling is consistent with ISO 5667-6:1990 (Water Quality – Sampling – Part 6: Guidance on sampling rivers and streams).

The following basic notes apply to surface water sample collection.

- Sampling of surface waters should ideally be undertaken during low flow or normal flow conditions rather than during storm/flooding events.
- It is preferable to sample directly into the sample container. This minimises the potential for cross-contamination from non-disposable equipment.
- Where a sampling device is required, however, (for example where access is difficult) the device can be tailored to the physical conditions for acquiring the sample, provided that the appropriate decontamination procedures are applied to non-disposable equipment and that disposable equipment is only used once at each location. Where such equipment is used, the collection device should also be rinsed three times with the water to be sampled prior to filling the sample containers.
- Collection methods should aim to minimise sample agitation to ensure minimum disturbance of samples to be collected for volatile and semi-volatile compounds analysis.

Where waters to be sampled are shallow, wading can be afforded provided there is no potential risk to the field operative and provided that measures are in place to protect the safety of the individual undertaking the sampling. Any special measures required should be detailed in a method statement within the health and safety plan prior to commencement of field activities. Under no circumstances shall water sampling be carried out alone.

Where entry into the water body takes place, the operative should minimise disturbance of bottom sediments which not only increases the turbidity of the sample, but may mobilise contaminants present within the sediments into the surface water sample. In any case, sampling shall be carried out upstream respect to the operative.

Information to be noted during collection of a surface water sample, should include the following where possible:

- Location of sampling point (either by GPS or other means)
- Details of the channel such as water depth, width of channel, etc. A simple sketch may be required to provide such information.
- An indication of flow conditions at the time of sampling. A flow meter is not necessarily required for this (unless specifically requested), but a simple floating device which is timed over a set distance will provide useful indicative information of the speed of flow of the watercourse.

Sample containers, sample preservation, storage conditions and holdings times for surface water samples shall be as detailed in Annex D.

The above methodology is considered suitable for generalised surface water quality sampling. Where a sample downstream of the confluence of two rivers is required, appropriate calculations must be undertaken to ensure the sample is collected sufficiently downstream of the confluence for complete mixing to occur. This calculation and other methods of sampling are detailed in ISO 5667-6:1990 – Water Quality – Sampling – Part 6: Guidance on sampling of rivers and streams. This document shall be the primary reference for surface water quality sampling where proposed methods are different to that described above.

10.8. Sediment Samples

For the purpose of this field methodology, it is assumed the practices below are applicable to sampling activities undertaken in rivers or any other inland surface watercourse (river, stream, lake, drainage ditch, etc.). These methodologies are not applicable to offshore sediment sampling activities.

Sampling should start at the most downstream location in the sample plan and move upstream to minimise impact from sediment disturbance in the watercourse.

When collecting samples, bottom sediments should usually be collected from embayments or eddies or from other areas where deposition is most likely to take place. Samples with high clay or organic content should be taken in preference to those which consist mainly of gravels. Whilst it is recognised that this will bias results towards higher concentrations, gravel samples cannot be analytically processed in a satisfactory way.

Samples will typically be collected from shallow, wadeable sections using either a grab sampler, corer or trowel. Where deeper watercourses are to be sampled, a boat and appropriate equipment may be required (as described for the offshore field surveys above).

Samples are transferred to a bowl and mixed to obtain a uniform sample. The sample shall then be transferred to sample containers. Where analysis for volatile or semi-volatile suites is to be undertaken, samples should be transferred directly to the containers without prior mixing. This ensures minimum disturbance of the sample.

Sample containers, preservation, storage conditions and timescales are as detailed in the table in Annex C.

11. ONSHORE FLORA AND FAUNA SURVEYS

The purpose of onshore flora and fauna surveys is to provide a quantitive and documented record of species occurrence, abundance and distribution based on observations in the field during survey works. No survey can fully quantify species presence and density within an area, however, the methods must be appropriate for the target species and habitats, and surveys must be conducted at optimum time for each target species and the relevant part of their lifecycle.

The purpose of the surveys is to equate a baseline condition with potential impacts from the oil and gas industry. The results of the baseline surveys will allow predictions to be made regarding the severity of any potential impacts. Mitigation strategies will then be devised which will reduce impacts to an acceptable level. In addition, by repeating some of the surveys during project development, at the most sensitive areas or areas where impacts could not be fully mitigated, the scale of any impacts can be quantified and re-evaluated. Monitoring will also highlight areas where mitigation measures are not proving effective. The survey is not a research project; the geographic scope is the project affected area.

Onshore ecological surveys are complex; the mosaic or network of habitats are used differentially – for breeding, nesting, foraging, hibernating. The sampling strategy must be designed to accommodate this information (e.g. timing and duration of surveys, survey location and appropriate survey method) as well as assessing how the project will effect each habitat.

Survey and sampling methods cannot be prescriptive; they must be species and location specific. For example, a survey could use different data gathering methods for the same species in different habitats; or survey methods may be selected to be compatible with past survey data. However, once selected the method will be executed with scientific rigour and precision and be transparent and repeatable.

Non-lethal sampling methods will be used, and trapping will only be used if no other method is available. Causing undue stress to animals will always be a high priority.

All survey data will be uploaded to GIS where it can be interrogated and managed.

11.1. Baseline Report Assessment

Onshore Baseline Survey Reports are many and varied, however, all should contain the following sections:

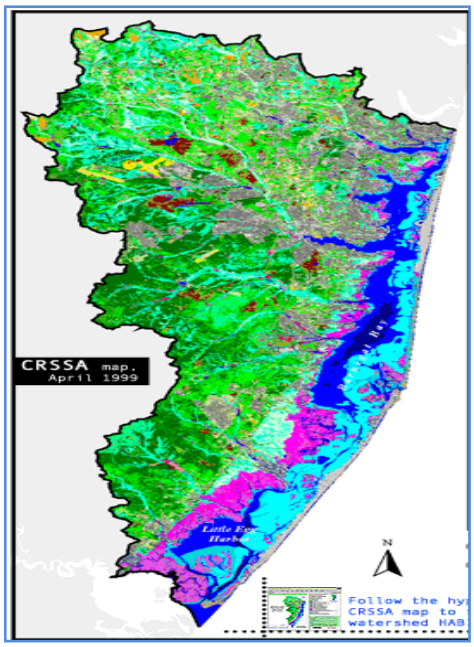
- Survey carried out in legally protected areas
- Survey carried out in non-protected areas
- River Corridor Survey carried out
- Survey carried out on all project affected areas
- Priority Habitats listed (IUCN, RDB etc)
- Priority Species listed (IUCN, RDB etc)
- Methodology included
- Raw field data included

- Impacts assessed
- Mitigation Measures described
- Monitoring recommendations described
- Data Uploaded to GIS
- Invasive species considered
- Agricultural diseases/pests considered
- Mosquitoes/human biting insects recorded
- Bee keeping locations recorded
- Sample size as representative of total resource;
  - project affected area,
  - national
- Adequate assessment of project affected areas, not just the development site eg access roads, potential pipe dumps, camps, quarries etc
- Competency of surveyor(s) assessment, including identification skills

11.2. Habitat Mapping

Habitat mapping is a key first stage in the onshore ecological baseline assessment. Google Earth can be useful in this context as a first pass desk top study, but ground truthing is essential. Recognised vegetation assemblages or plant communities and land cover are the criteria used to describe habitats. In the absence of a nationally recognised classification scheme broad categories for the purpose of habitat mapping are easy to compile, and will include the following:

- Forest - Mixed
- Forest - Deciduous
- Forest - Coniferous
- Scrub
- Grassland – anthropogenic
- Grassland – natural
- Grassland - dune
- Cropland
- Wetland – marsh / fen
- Riparian
- Aquatic – emergent
- Aquatic – bank
- Salt Marsh
- Bare rock
- Bare sand



The habitat map will be used to scope the ecological field surveys. Suitable habitats for each species will be identified and broad locations for survey selected. These locations will be verified in the field. Habitat maps will also be used to advise the project on the least damaging areas suitable for development.

Once the habitat classification has been agreed it will be uploaded as a GIS layer.

11.3. Flora

Having established the broad habitat and vegetation types, two different (but interrelated) surveys will be designed; one to characterise the ecologically valuable vegetation types using information acquired using quadrat placements and the other to identify and locate rare and protected plant species. Standard phytosociological techniques will be applied; ie homogenous stands of vegetation are identified and randomly selected quadrats are placed with all species identified within them. Cover and abundance scores are given for each species present. Braun-Blanquet classification is not appropriate for these surveys as it is too academic and does not provide a workable nomenclature to observed plant communities.

A Botanical recording form must contain the following data:

- Plot code
- GPS
- Relief
- Aspect
- Slope
- Soil (type, depth, moistness etc)
- Habitat
- Management (disturbance etc)
- Ground cover (%rock, litter etc)
- Vegetation (cover, height,type)
- Forest layer (regeneration, dead wood etc)
- Bryophytes and Lichens % cover
- Plant Community name

11.4. Birds

Ornithological surveys provide a documented account of the status of the bird population in the region at the time of the survey. The survey aim is to collect basic observational data including the following:

- Species identification
- Observations in different landscape-ecological conditions
- Total observed numbers, species dominance in the variety of biotopes and density per square kilometre

Surveys will use a standard methodology, usually Bibby 1999, but it is important to select one which is most appropriate. An overall bird survey will have tend to use systematically selected observation stations, eg every 10km along a route, with observations 100m either side of the transect with birds, both flushed and in transit, registered., Other information such as direction of flight, observed nests, recognised bird singing, footprints, droppings and feathers observations are also recorded as part of the survey. Specific surveys, such as rare species and wintering bird surveys will be focussed around the specific location, for example a wetland .

Depending on habitat and season there will be several bird surveys undertaken. Surveys will be focus on:

- Migratory Flyways
- Nesting Birds
- Coastal Birds
- Overwintering Birds
- Rare species monitoring

Field survey sheets for all survey methods will include the following data:

- Date
- Time
- Location – GPS
- Sampling Method
- Weather Conditions
- Habitat Type
- Species
- Male/Female
- Adult/Juvenile
- Behaviour (Nesting, Feeding, Roosting etc)

11.5. Mammals

There will be an appropriate survey methodology for each mammal species and for the type of habitat in which the survey is taking place. These tend to be walked transects with recorded observations. A survey will be required for all rare and protected mammals that could potentially be affected by oil and gas developments. Many surveys traditionally used trapping methods, but this is now considered outmoded and detrimental to the health and wellbeing of the animals. Detailed observations on incidence of burrows, tracks, dung, food remains etc provide sufficient data on presence and density on which to base mitigation measures. Nocturnal observations are carried out where appropriate.

Bats

All Bats are legally protected, so a Bat survey will almost certainly be required. This will include a search for signs of bats as well as potential roosting sites in buildings and trees which are to be affected by a development.

Dusk/Dawn Emergence Surveys involve recording the numbers and species of bats leaving or re-entering a bat roost. A range of specialist equipment will be used including heterodyne bat detectors and highly trained staff out in the field and advanced Anabat detectors with Analook software to get accurate information on any bat species present.

Activity Surveys; some habitats are particularly important for bats to feed or to commute from a roost to foraging ground. Activity surveys determine how bats are using the site and therefore enable mitigation measures to be designed which reduces impacts on their use of the site.

11.6. Reptiles and Amphibians

Selected sites, based on the likelihood of species using the habitat, will be visited in appropriate weather conditions and at the optimum time of year for observation and species activity. The following information will be recorded.

- Date, start/finish times, weather variables (which determine detectability)
- Location - GPS
- Extent suitable habitat (to assess the likelihood of presence)
- Time spent, distance walked, extent of apparent habitat covered (to assess effort applied)
- Methods used - visual search, artificial refugia (numbers, materials), pre-existing refugia
- Animal seen (species, sex)
- Life stage (eg egg, juvenile)

- Confidence in identification

With Amphibians up to three techniques will be used to survey the pond: visual search (including egg search), netting and torchlight survey (after dark). Information about the pond, and the conditions under which the survey was made, will be recorded on a survey form provided.

11.7. Terrestrial Invertebrates

Invertebrates surveys are aimed at determining species composition and numbers.

Invertebrates are caught using standard entomological net by method of sweeping along vegetation at a fixed frequency of 100 net sweeps, catching specimens in flight and from surfaces (i.e. vegetation).

Other survey methods, in particular for undertaking species counts in soil, involve digging a 0.5 x 0.5m square of soil to a depth of 0.2m and collecting the retrieved specimens.

Night surveying of invertebrates is undertaken using a 100 x 200cm white screen and electric lamp (typically 200W). The screen is set 2.5 m above the ground level in a vertical position, with the lamp set to ensure the screen is fully covered with light. This type of sampling should be undertaken approximately every 3-5 days during a survey period.

As much identification as possible will be carried out in the field to avoid the need for lethal sampling techniques. The trend now is to use ecological interpretation and indicators to assume potential presence/absence, for example the presence of a plant species which is critical for the survival of an invertebrate.

11.8. Fish and Aquatic Invertebrates

The purpose of fish sampling is to acquire data on species presence and population density. Identification will follow standard taxonomy.

Fish are typically sampled during low flow using electrofishing techniques (SAMUS-725G). Depending on the type of water body two methods to assess fish abundance are used:

- Depletion method (Zippin method) used for small rivers and streams.
- Point abundance sampling (PAS) used in lakes and big rivers

Fish will be identified, counted, their length measured length and released after the second pass.

This procedures is recommended in EN 14011 European Standard; Water Analysis – Sampling of fish with electricity (CEN, 2003).

Aquatic Invertebrates are sampled by counting individuals along transects and using kick netting.

The habitat will be described using the following criteria:

- Location –GPS
- Naturalness of habitat (using one of the standard classifications)
- River canalization and bank modification
- Water fragmentation (weir, water power plants, water falls)
- Type of bottom substrate
- Sand and pebbles dragging
- Water velocity
- Water depth
- Water quality and chemistry (pH, turbidity, EC, temperature)
- Impact sources of water pollution
- Diffuse sources of water pollution

11.9. Photographic Record

A comprehensive photographic record will be part of all surveys. Each photograph will be accompanied by the following record, which will be managed through the project GIS.

- Unique Photo number -
- Date/Time
- GPS
- Direction – N,S,E,W
- Subject Category (eg Flora, Equipment, Erosion etc)
- Feature (eg River name etc)
- Reason for Photo (eg Monitoring, Audit, Incident etc)

12. SOCIAL AND HEALTH SURVEYS

12.1. Social Surveys and Methods.

Social Surveys in the context of large development projects do not as yet work to any regulatory framework and there are very few international conventions covering this area. In the absence of these guidelines most large projects adopt the IFC (International Financial Corporation) Performance Standards. These are described in detail on the IFC website, in multiple languages and with comprehensive guidance notes.

The principle of any social-economic baseline survey is essentially the same and the methods used to collect the data follow a standard scientific approach – measurable, attainable, repeatable and timely. However, humans have a volatile quality and the surveyor must be able to adjust or make additions to surveys during the data collection process.

Social surveys are a combination of a desktop study of existing (secondary) data in conjunction with primary data, collected specifically for the project. The aim of primary data collection is to compare with existing data, fill any existing gaps and comprehensively represent all views and attributes of a project affected community. A sound assessment of secondary data will enable formulation of culturally appropriate questions whilst collecting the primary data.

12.2. Social survey Requirements:

- The Zone of Influence must be identified and taken into account during selection.
- Surveys must be fully planned, methodical and systematic – humans are not like animals, they react to gossip, rumours, fears and propaganda. Multiple complications will arise if surveys need re-doing.
- Construction of a detailed plan and outline of proceedings. It is important that all project affected settlements are questioned within the same time frame, failing to do so can alter results dramatically. It is important to understand protocol and know who to target first, for example mayors before households.
- An experienced and qualified survey team. IFC stipulate that “Specific studies should be undertaken by qualified and experienced professionals using standard sampling programmes and tools” (IFC Guidance Note 6).

The socio-economic field surveys generally consist of:

Mayors Questionnaire

Questionnaires aimed at mayors, or other high standing figures within a community, are first of the surveys to be conducted and they are followed up with on-going consultations. These head figures form the main access to the community therefore they require a high level of project information. Certain sub-groups in society may have their own head figure that must be identified in the early stages; this is especially relevant in the ethnically diverse conditions in Lebanon

All mayors from project affected communities (100% sample) will be interviewed with a questionnaire containing the following:

- Settlement population – (ethnicity, gender, age, disabilities, religions)
- Settlement birth/death rates, literacy, employment/unemployment. Known level of literacy is especially important in order to pitch the household questionnaires appropriately.
- Settlement Culture and hierarchy (including areas of conflict)
- Settlement infrastructure and local amenities
- Forms of communication – what forms of telecommunications are accessible to the population? (This is vital information when planning stakeholder and community engagement strategies)
- Personal and professional observations/opinions in relation to foreseen Project impacts (both negative and positive)
- Land ownership and land use (especially ports and harbours)
- Areas of concern – physical (low slung electric lines) or culturally (regarding population sensitivities (health issue for example), crime rates and types.
- Sensitive locations – schools, hospitals, place of worship or spiritual significance, tourism or cultural recreation areas.

Household Questionnaires

Households from project affected communities will be sampled using a statistically valid sampling technique. The household interviews should be staggered throughout the day to ensure that a range of the population is questioned. Busy times of year, such as harvest times should be avoided as detailed interviews could be a nuisance. The questionnaire will include:

- Household members –number of inhabitants, hierarchy, age, gender, ethnicity, race, education level, general health (do not touch on sensitive health issues)
- Type of dwelling
- Assessment of wealth and poverty, people do not like to be asked directly how much they earn in any culture so questions should be aimed at indicators such as possessions (mobile phone, television, cars etc). The questions must be culturally specific
- Land use and ownership
- Sensitive or culturally important areas – places of worship etc.
- Observations and opinions on existing amenities and lifestyle within their settlement
- Opinions on existing infrastructure and transport network within their settlement
- Pre-existing knowledge on Pipelines, fears, perceptions and expectations

Focus Group Discussions

From consultations and questionnaires it will become obvious that there are groups within the communities that have particular concerns; these are stakeholders with a very specific interest in project development. An on-going dialogue should be set up with particular Focus Groups which encourages open discussion between them and project owners.

Focus Groups that are immediately apparent include:

- Fishermen and fishery co-operatives – as the oil and gas development starts offshore this group will feel the impacts first. Fishermen are a very influential and well organized group that will be quite vocal in their concerns.
- Hoteliers and coastal tourist industry – potentially this group could have their businesses and livelihood significantly impacted.
- Refugee camp inhabitants – potentially this group may face negative impacts from oils and gas development and will need to be addressed with careful consideration and a comprehensive plan. According to reliable sources these camps follow tribal rules and are not typical of mainstream Lebanese society.
- Women – a common problem in household surveys is that the man of the house may directly or indirectly control what is said to the interviewee. Women often have a different perception than men, therefore both sides need to be heard. This may or may not be an issue in Lebanon and can only be assesses after initial household surveys have commenced.
- Medical professionals – information on health issues in Lebanon is scarce. It may be necessary to acquire opinions and credible data from health professionals. The general state of disrepair of civil infrastructure, domestic water and air quality all impact on health conditions in Lebanon, although recorded data is minimal.

Social surveys run in parallel with a comprehensive stakeholder engagement plan. A Comments and Complaints system (often called a Grievance Mechanism) must be in place at an early stage in project development to facilitate constructive dialogue.

Vulnerable Groups

It is important to consider the social equity or distribution of impacts across different groups of people. Just as the biological sections of ESIAs devote particular attention to threatened or endangered plant and wildlife species, the socio-economic sections of ESIAs must devote particular attention to the impacts on vulnerable segments of the human population. IFC stipulate that there are six main categories describing vulnerable groups that must be addressed in socio-economic surveys, if they exist in the population. These are:

- Indigenous Peoples
- Ethnic or Religious Minorities
- Women,
- Youth and Elderly
- Handicapped
- Land users without any formal rights (squatters)

Community engagement is now considered an integral component of any project development where a win:win outcome is sought. The earlier the stakeholder engagement process starts the better.

13. CULTURAL HERITAGE SURVEY

Offshore and onshore field survey will be necessary. Some of this survey will be analysing activities carried out for other purposes.

13.1. Bathymetric/Geophysical Survey

Data from the bathymetric/geophysical survey of Lebanese offshore water undertaken under the proposed terms of the ESIA should be examined by a specialist in the interpretation of maritime geophysics. In the absence of specific Lebanese or international standards or guidance, the most applicable guidance for such work is probably recently published UK guidance relating to the development of offshore renewable energy (EMU 2011). The output of this work should include a GIS database of anomalies of potential archaeological significance and an analytical report setting out the overall findings of the survey in the context of previous knowledge and understanding of the maritime resources of the region.

The specification for data collection methodology should be agreed in consultation with a specialist in the interpretation of maritime geophysics. It may be necessary and appropriate in some areas (eg close to the World Heritage sites of Byblos and Tyre as well as other important ancient port sites) to increase the resolution of data collection in order to provide better data about seabed conditions in areas of established high sensitivity.

13.2. Desk-Based Assessment

Offshore

Desk-based assessment of the offshore cultural heritage resource is a key foundation for a baseline understanding of the area. In the absence of Lebanese or international standards, useful guidance is provided by the published standards produced by the UK Institute for Archaeologists (IFA, 1999). This should include consultation of the following sources:

- the archives of the DGA;
- published results of maritime archaeological exploration in Lebanese waters including academic journals and books;
- individuals within the DGA and academic institutions in Lebanon and abroad with specialist knowledge of the underwater archaeology of the region;
- primary documentary sources including historic charts, which should be scanned and geo-referenced wherever possible.

The output of the desk-based assessment should include an analytical report with a comprehensive gazetteer of identified sites and a corresponding GIS database.

Onshore

The desk-based assessment of the coastal cultural heritage resource should again refer to the published IFA guidance. By contrast with the offshore environment, a great deal of archaeological research and documentation has been carried along the coast of Lebanon over the past 150+ years, resulting in hundreds if not thousands of published books and articles. Collating this data into a focussed geographical dataset is therefore a considerable task. It will be important that this work is carried out in close consultation with the DGA. The incorporation of any existing digital datasets that may be held by the DGA of sites on the coastal zone could provide considerable saving in time, effort and cost.

Other potential sources of information that should be consulted include:

- published results of archaeological exploration along the Lebanese coast including academic book and journals such as Baal, Archaeology and History in Lebanon, Mélanges de l'Université St Joseph, and Berytus;
- specialists within the DGA and academic institutions in Lebanon and abroad;
- primary documentary sources including historic maps, which should be scanned and georeferenced wherever possible;
- archives held by institutions such as the American University in Beirut (AUB), the Institut Français d'Archéologie Orientale (IFAO), and the Geographic Service of the Lebanese Army;
- national libraries and collections in the UK (British Library and the Public Record Office) and France (the Bibliothèque Nationale and the military archives at the Chateau de Vincennes) may also hold valuable information including historic maps, charts and travellers' descriptions;
- remote sensing sources such as aerial photographic archives (particularly from the period pre-dating 1970) and satellite imagery.

13.3. GIS Mapping

All sites identified by the desk-based assessments and offshore geophysical survey should be compiled into a single GIS database. Software and data standards for this database should be agreed in advance with the DGA. Possible international standards include the MIDAS standards developed for the UK National Monuments Record; JARDIS, the system employed for the Jordanian national heritage database and those employed in the recently developed national heritage database of Qatar.

13.4. Final ESIA chapter and Risk Mapping

Following completion of desk-based work, geophysical analysis and GIS mapping, the ESIA should be produced which will include a heritage risk-map for use during the development of oil and gas in Lebanese waters. This will, as a minimum identify the following:

- High risk/sensitivity areas where development activity should be avoided if at all possible;
- Medium risk areas where fieldwork should be carried out in advance of any proposed development
- Low risk areas where no further measures are thought necessary.

The ESIA chapter will also set out in detail mechanisms and procedures for assessment, mitigation and monitoring of specific operations involved oil and gas exploration (eg test drilling, construction of oil & gas platforms, offshore and onshore pipeline construction, terminal and refinery construction). These will be established in close collaboration with the DGA and should be in accordance with Lebanese Antiquities Law, and the UNESCO Conventions on World Heritage and the Protection of Underwater Cultural Heritage. They should also take into account existing standards and guidance developed in other countries such as recently published UK guidance (JNAPC 2006; The Crown Estate 2010a & 2010b).

Appendices

APPENDIX A

SUMMARY OF GUIDELINE REFERENCE DOCUMENTS USED IN THE INSTRUCTION MANUAL

International Standards Organisation (ISO)

- ISO 10381-3 (2001) – Soil Quality – Sampling Part 3: Guidance on Safety
- ISO 5667-1 (1996): Water Quality – Sampling – Part 1: Guidance on the Design of Sampling Programmes.
- ISO 5667-2 (1991): Water Quality – Sampling – Part 2: Guidance on Sampling Techniques.
- ISO 5667-3 (2003): Water Quality – Sampling – Part 3: Guidance on the Preservation and Handling of Water Samples
- ISO 5667-14 (1998): Water Quality – Sampling – Part 14: Guidance on Quality Assurance of Environmental Water Sampling and Handling.
- ISO 5667-9 (1992): Water Quality – Sampling – Part 9: Guidance on Sampling from Marine Waters
- ISO 5667-15 (1999): Water Quality – Sampling – Part 15: Guidance on the Preservation and Handling of Sludge and Sediment Samples
- ISO 5667-19 (2004): Water Quality – Sampling – Part 19: Guidance on Sampling in Marine Sediments.
- ISO 11074-1, Soil Quality – Vocabulary – Part 1: Terms and definitions relating to the protection and pollution of the soil
- ISO 11074-2, Soil Quality – Vocabulary – Part 2: Terms and definitions relating to sampling
- ISO 11074-3, Soil Quality – Vocabulary – Part 3: Terms and definitions related to the rehabilitation of soils and sites
- ISO 10381-2 (2002): Soil Quality – Part 2: Guidance on Sampling Techniques
- ISO 5667-6 (1990): Water Quality – Sampling – Part 6: Guidance on Sampling of Rivers and Streams
- ISO 5667-4 (1987): Water Quality – Sampling – Part 4: Guidance on Sampling from Lakes, Natural and Man-Made.
- ISO 5667-11 (1993): Water Quality – Sampling – Part 11: Guidance on Sampling of Groundwaters

APPENDIX B

References for Glossary of Terms

The definitions have been extracted from the following documents:

- ISO 11074-1 – Soil Quality Vocabulary – Part 1: Terms and definitions relating to the protection and pollution of soil
- ISO 11074-2 – Soil Quality Vocabulary – Part 2: Terms and definitions relating to the protection and pollution of soil
- ISO 6107-1 – Water Quality Vocabulary – Part 1
- ISO 6107-2 – Water Quality Vocabulary – Part 2
- ISO 6107-3 – Water Quality Vocabulary – Part 3 and Amendment 1
- ISO 6107-4 – Water Quality Vocabulary – Part 4
- ISO 6107-5 – Water Quality Vocabulary – Part 5
- ISO 6107-8 – Water Quality Vocabulary – Part 8 and Amendment 1

*A number of terms were not present within the ISO guidelines above and therefore a description/definition of these terms was taken from a range of sources identified through the internet.

APENDIX C

SOIL AND SEDIMENT SAMPLES - SAMPLE CONTAINERS, PRESERVATION AND STORAGE CONDITIONS

The preservation method, storage conditions and duration of storage provided in the table below are taken from ISO 5667-15 – Water Quality – Sampling – Guidance on the Preservation and Handling of Sludge and Sediment Samples. The following guidelines shall also be applied to soil samples.

Analysis or test	Container	Preservation	Storage Conditions	Storage Duration	International Standard
Acidity	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	14 days	
Alkilinity	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	14 days	
PH	Sampling device	Wet undisturbed	Determined in the field	None	
PH (with temperature correction)	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	24 h	
Conductivity	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	24 h	
Kjeldahl nitrogen	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	1 month	
Ammoniacal nitrogen	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	As short as possible	
Total residue	Glass	Refrigerate	2ºC to 5ºC/dark/airtight	8 days	
Anions (e.g. sulphate)	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	28 days	ISO 11048
Nitrate	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	2 days	
Nitrite	Polyethylene/ Glass	Refrigerate	2ºC to 5ºC/dark/airtight	As short as possible	
Sulfide	Polyethylene/ Glass	Refrigerate PH>10.5	2ºC to 5ºC/dark/airtight/anoxic	As short as possible	
Phosphorus	Glass	Refrigerate	2ºC to 5ºC/dark/airtight	1 month	
Orthophosphate	Glass	Refrigerate	2ºC to 5ºC/dark/airtight	2 days	
Cyanides	Polyethylene	Freeze	<-20ºC/dark/airtight	1 month	
Metals	Polyethylene Polyethylene Polyethylene	Refrigerate Freeze Dry (60ºC)	2ºC to 5ºC/dark/airtight <-20ºC /dark/airtight Ambient temperature dark/airtight	1 month 6 months 6 months	
Mercury	Glass/PTFE	Refrigerate Freeze	2ºC to 5ºC/dark/airtight <-20ºC/dark/airtight	8 days 1 month	
Chromium (VI)	Polyethylene	Refrigerate	2ºC to 5ºC/dark/airtight	2 days	
Particle Size	Polyethylene/ Glass/Metal	Refrigerate	2ºC to 5ºC/dark/airtight	1 month	
TOC	Glass with PTFE-lined cap	Refrigerate Freeze	2ºC to 5ºC/dark/airtight <-20ºC/dark/airtight	1 month 6 months	
Semi- and non-volatile organic compounds (PCB's, PAH's, pesticides, high molecular weight hydrocarbons)	Glass with PTFE-lined cap Aluminium foil/Glass with aluminium foil	Refrigerate Freeze Dry	2ºC to 5ºC/dark/airtight <-20ºC/dark/airtight Ambient temperature dark/airtight	1 month 6 months 6 months	
Mineral oil	Glass with PTFE-lined cap	Refrigerate Freeze	2ºC to 5ºC/dark/airtight <-20ºC/dark/airtight	24 h 1 month	
Volatile organic analysis as-received	Glass/metal rings with PTFE-lined cap	Refrigerate/addition of methanol Freeze	2ºC to 5ºC/dark/airtight <-20ºC/dark/airtight	As short as possible 1 month	
Ecotoxicological tests	Polyethylene/Glass	Refrigerate	2ºC to 5ºC/dark/airtight	14 days [a]	ISO 5667-16
Bacteriological examination	Sterile glass	Refrigerate	2ºC to 5ºC/dark/airtight	6 h	
Microbial activitiy	Sterile glass	None		None	
Ecological examination	Polyethylene/Glass	70% (vol. Fraction ethanol) 4% (vol. Fraction formalin)	2ºC to 5ºC/dark/airtight	1 year 1 year	ISO 5667-3

[A] Analysis should be started as soon as possible

APPENDIX D

WATER SAMPLES - CONTAINERS, VOLUME, PRESERVATION AND HOLDING TIMES

The following table is taken from ISO 5667-3:2003 – Water Quality – Sampling – Part 3: Guidance on the Preservation and Handling of Water Samples. It shall be applied to all water samples collected during environmental surveys (seawater, groundwater, surface water).

eterminand to be studied	Type of container [a]	Typical volume (ml) and filling technique [b]	Preservation technique	Maximum recommended preservation time before analysis after preservation	Comments
Acidity and alkalinity	P or G	500 Fill container completely to exclude air	Cool to between 1ºC & 8ºC	24 h	14 days [c] Samples should preferably be analysed on-site (particularly for samples high in dissolved gases). Reduction and oxidation during storage can change the sample.
Acidic herbicides	G with PTFE cap liner or septum	1000 Do not pre-rinse the empty container with sample; analytes adhere to the wall of the bottle. Do not completely fill sample container.	Acidify to between pH1 to 2 with HCl & cool to between 1ºC & 5ºC	2 weeks	Extract sample container as part of the sample extraction procedure. If the sample is chlorinated, for each 1000ml of sample add 80mg or $Na_2S_2O_3.5H_2O$) to the container prior to collection.
Adsorbable organic halides (AOX)	P or G	1000 Fill container completely to exclude air.	Acidify to between pH1 to 2 with HNO_3, cool to between 1ºC to 5ºC, keep samples stored in the dark	5 days	
	P	1000	Freeze to -20ºC	1 month	
Aluminium	P acid washed G or BG acid washed	100	Acidify to between pH1 to 2 HNO_3	1 month	
Ammonia, free and ionized	P or G	500	Acidify to between pH1 to 2 with H2SO4, cool to between 1ºC & 5ºC	21 days	Filter on-site before preservation
	P	500	Freeze to -20ºC	1 month	
Anions (Br, F, Cl, NO_2, NO_3, SO_4 and PO_4)	P or G	500	Cool to between 1ºC & 5ºC	24h	Filter on-site before preservation. See also ISO 10304-1
	P	500	Freeze to -20ºC	1 month	
Antimony	P acid washed G acid washed	100	Acidify to between pH1 & 2 with HCl or HNO_3.	1 month	HCl should be used if the hydride technique is used for analysis
Arsenic	P acid washed G acid washed	500	Acidify to between pH1 & 2 with HCl or HNO_3.	1 month	HCl should be used if the hydride technique is used for analysis
Barium	P acid washed G acid washed	100	Acidify to between pH1 & 2 with HCl or HNO_3.	1 month	Do not use H_2SO_4
Beryllium	P acid washed G acid washed	100	Acidify to between pH1 & 2 with HCl or HNO_3.	1 month	
Biochemical Oxygen Demand (BOD)	P or G	1000 Fill container completely to exclude air	Cool to between 1ºC & 5ºC	24 h	Keep samples stored in the dark. In case of freezing to –20ºC: 6 months (1 month if <50mg/l)[c]
	P	1000	Freeze to –20ºC	1 month	
Boron	P	100 Fill container completely to exclude air	None required	1 month	6 months [c]
Bromate	P or G	100	Cool to between 1ºC & 5ºC	1 month	
Bromide and bromine compounds	P or G	100	Cool to between 1ºC & 5ºC	1 month	
Bromine residual	P or G	500	Cool to between 1ºC & 5ºC	24 h	Keep samples stored in the dark. The analysis should be carried out on-site, within 5 min of sample collection
Cadmium	P acid washed or BG acid washed	100	Acidify to between pH1 an 2 with HNO_3	1 month	6 months [c]
Calcium	P or G	100	Acidify to between pH1 an 2 with HNO_3	1 month	
Carbamate pesticides	G solvent-washed	1000	Cool to between 1ºC & 5ºC	14 days	If the sample is chlorinated, for each 1000ml of sample add 80mg of $Na_2S_2O_3.5H_2O$ to the container prior to analysis.
	P	1000	Freeze to –20ºC	1 month	
Carbon dioxide	P or G	500 Fill container completely to exclude air	Cool to between 1ºC & 5ºC	24 h	Determination preferably carried out on-site.
Carbon, total organic (TOC)	Pr or G	100	Acidify to between pH1 an 2 with H_2SO_4, cool to between 1ºC & 5ºC	7 days	Acidification to pH1 to 2 with H_3PO_4 is suitable. If volatile organic compounds are suspected,

eterminand to be studied	Type of container [a]	Typical volume (ml) and filling technique [b]	Preservation technique	Maximum recommended preservation time before analysis after preservation	Comments
	P	100	Freeze to –20ºC	1 month	acidification is not suitable. Analyse within 8h
Chemical oxygen demand (COD)	P or G	100	Acidify to between pH1 an 2 with H_2SO_4	1 month	6 months [c]
	P	100	Freeze to –20ºC	1 month	6 months [c]
Chloramine	P or G	500		5 min	Keep samples stored in the dark. The analysis should be carried out on-site, within 5 min of sample collection.
Chlorate	P or G	500	Cool to between 1ºC & 5ºC	7 days	
Chloride	P or G	100		1 month	
Chlorinated Solvents	G, headspace vials with PTFE caps	250 Fill container completely to exclude air	Acidify to between pH1 & 2 with HCl	24h	If the sample is chlorinate, for each 250ml of sample, add 20mg of $Na_2S_2O_3.5H_2O$ to the container prior to analysis. For purge and trap, HCl interferences. See specific standard for preservation.
			Cool to between 1ºC and 5ºC	24h	
Chlorine dioxide	P or G	500		5 min	Keep samples stored in the dark. The analysis should be carried out in the field, within 5 min of sample collection.
Chlorine, residual	P or G	500		5 min	Keep samples stored in the dark. The analysis should be carried out in the field, within 5 min of sample collection.
Chlorite	P or G	500	Cool to between 1ºC and 5ºC	5 min	Keep samples stored in the dark. The analysis should be carried out in the field, within 5 min of sample collection.
Chlorophyll	P or G	1000	Cool to between 1ºC and 5ºC	24h	Transport in amber coloured bottles
	P	1000	After filtration and extraction with hot ethanol, freeze to –20ºC	1 month	
	P	1000	After filtration, freeze to –20ºC	1 month	
Chromium	P acid washed or G acid washed	100	Acidify to between pH1 & 2 with HNO_3	1 month	6 months [c]
Chromium (VI)	P acid washed or G acid washed	100	Cool to between 1º & 5ºC	24 h	Reduction and oxidation during storage can change the sample concentration
Cobalt	P acid washed or BG acid washed	100	Acidify to between pH1 & 2 with HNO_3	1 month	6 months [c]
Colour	P or G	500	Cool to between 1ºC and 5ºC	5 days	Keep the samples stored in the dark. In case of groundwater, rich with iron(II), analysis should be carried out on-site within 5 min of sample collection.
Conductivity	P or BG	100 Fill container completely to exclude air.	Cool to between 1ºC and 5ºC	24 h	Analysis preferably carried out on-site
Copper	P acid washed or G acid washed	100	Acidify to between pH1 & 2 with HNO_3	1 month	6 months [c]
Cyanide by diffusion at pH6	P	500	Add NaOH to pH>12 Cool to between 1ºC & 5ºC	24 h	
Cyanide easily liberated	P	500	Add NaOH to pH>12 Cool to between 1ºC & 5ºC	7 days 24h is sulphide is present	Keep samples stored in the dark
Cyanide, total	P	500	Add NaOH to pH>12 Cool to between 1ºC & 5ºC	7 days 24h is sulphide is present	14 days [c] Keep samples stored in the dark
Cyanochloride	P	500	Cool to between 1ºC & 5ºC	24 h	
Detergents	See “Surfactants”				
Dissolved Solids (dry residue)	See “Total Solids (Total residues)”				
Fluorides	P but not PTFE	200		1 month	
Heavy metal compounds (except mercury)	P or BG	500	Acidify to between pH1 & 2 with HNO_3	1 month	6 months [c]
Hydrazine	G	500	Acidify with HCl to 1mol/l	24 h	Keep samples in the dark
Hydrocarbons	G solvent (e.g. pentane) used for extraction	1000 Do no pre-rinse container with sample: analytes adhere to the wall of the bottle. Do not completely fill the	Acidify to between pH1 to 2 with H_2SO_4 or with HCl	1 month	Extract on-site where practical

eterminand to be studied	Type of container [a]	Typical volume (ml) and filling technique [b]	Preservation technique	Maximum recommended preservation time before analysis after preservation	Comments
		sample container.			
Hydrogen-carbonates	See "Acidity and Alkalinity"				
Iodide	G	500	Cool to between 1ºC & 5ºC	1 month	
Iodine	G	500	Cool to between 1ºC & 5ºC	24 h	Keep samples stored in the dark
Iron(II)	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HCl and exclusion of atmospheric oxygen.	7 days	
Iron, total	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	
Kjeldahl nitrogen	P or BG	250	Acidify to between pH1 to 2 with H_2SO_4	1 month	Keep samples stored in the dark. 6 months for both techniques [c]
	P	250	Freeze to –20ºC	1 month	
Lead	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	6 months [c]
Lithium	P	100	Acidify to between pH1 to 2 with HNO_3	1 month	
Magnesium	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	
Manganese	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	
Mercury	BG acid washed	500	Acidify to between pH1 to 2 with HNO_3 and addition of $K_2Cr_2O_7$ (0.05% by mass final concentration)	1 month	Particular care is needed to ensure that the sample is free from contamination
Monocyclic aromatic hydrocarbons	G, vials with PTFE lined septum	500 Fill container completely to exclude air	Acidify to between pH1 to 2 with H_2SO_4	7 days	If the sample is chlorinated, for each 1000ml of sample add 80mg of $Na_2S_2O_35H_2O$ to container prior to sample collection
Nickel	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	6 months [c]
Nitrate	P or G	250	Cool to between 1ºC and 5ºC	24 h	
	P or G	250	Acidify to between pH1 to 2 with HCl	7 days	
	P	250	Freeze to –20ºC	1 month	
Nitrite	P or G	200	Cool to between 1ºC and 5ºC	24 h	Analysis should preferably be carried out on-site 2 days [c]
Nitrogen total	P or G	500	Acidify to between pH1 to 2 with H_2SO_4 [d]	1 month	
	P	500	Freeze to –20C	1 month	
Odour	G	500	Cool to between 1ºC and 5ºC	6 h	The test can be carried out on-site (qualitative analysis)
Oil and grease	G solvent washed	1000	Acidify to between pH1 to 2 with H_2SO_4 or HCl	1 month	
Organic chlorine	See "Adsorbable organic halides (AOX)"				
Organotin compounds	G	500	Cool to between 1ºC & 5ºC	7 days	Extraction of the sample should be carried out on-site
Organophosphates, dissolved	See "Phosphorus, dissolved"				
Orthophosphates, total	See "Phosphorus, total"				
Oxygen	P or G	300 Container should be filled completely		4 days	Fix the oxygen on-site and keep samples stored in the dark. The electrochemical method may be used as well and can be carried out on-site.
Permanganate index	G or P	500	Acidify to between pH1 to 2 with H_2SO_4, 8 mol/l	2 days	Analyse as soon as possible
	G or P	500	Cool to between 1ºC and 5ºC and keep the samples stored in the dark	2 days	
	P	500	Freeze to –20ºC	1 month	
Pesticides, organochlorine, organophosphorus and organo-nitrogen containing	G solvent washed with PTFE cap liner For glyfosate use P	1000 to 3000 Do not pre-rise container with sample: analytes adhere to the wall of the bottle. Do not completely fill the container.	Cool to between 1ºC & 5ºC	Preservation time of the extract is 5 days	If sample is chlorinated, for each 1000ml of sampl add 80mg of $Na_2S_2O_35H_2O$ to the container prior to sample collection. Extraction should be carried out within 24 h after sampling.
Petroleum and derivatives	See "Hydrocarbons"				
pH	P or G Fill container completely to exclude air	100	Cool to between 1ºC and 5ºC	6 h	The test should be carried out as soon as possible and preferably immediately on-site after sampling

eterminand to be studied	Type of container [a]	Typical volume (ml) and filling technique [b]	Preservation technique	Maximum recommended preservation time before analysis after preservation	Comments
Phenol index	G	1000	Inhibit biochemical oxidation by addition of $CuSO_4$ and acidify to pH<4 with H_3PO_4	21 days	
Phenols	BG, amber, solvent-washed with PTFE cap liner	1000 Do not pre-rinse container with sample: analytes adhere to the wall of the bottle. Do not completely fill sample container.	Acidify between pH<4 with H_3PO_4 or H_2SO_4	3 weeks	If sample is chlorinated, for each 1000ml of sample add 80mg of $Na_2S_2O_35H_2O$ to the container prior to sample collection. For chlorophenols the extraction period is 2 days.
Phosphorus, dissolved	G or BG or P	250	Cool to between 1ºC and 5ºC	1 month	The sample should be filtered on-site at the time of sampling. Before analysis, oxidising agents may be removed by addition of iron(II) sulphate or sodium arsenate.
	P	250	Freeze to –20ºC	1 month	
Phosphorus, total	G or BG or P	250	Acidify to between pH1 to 2 with H_2SO_4 [d]	1 month	See "Phosphorus dissolved" 6 months for both techniques [c]
	P	250	Freeze to –20ºC	1 month	
Polychlorinated biphenyls (PCB's)	G, solvent-washed with PTFE cap liner	1000 Do not pre-rinse container with sample: analytes adhere to the wall of the bottle. Do not completely fill sample container.	Cool to between 1ºC and 5ºC	7 days	Extract on-site where practical. If sample is chlorinated, for each 1000ml of sample add 80mg of $Na_2S_2O_35H_2O$ to the container prior to sample collection.
Polycyclic Aromatic Hydrocarbons (PAH's)	G, solvent-washed with PTFE cap liner	500	Cool to between 1ºC and 5ºC	7 days	Extract on-site where practical. If sample is chlorinated, for each 1000ml of sample add 80mg of $Na_2S_2O_35H_2O$ to the container prior to sample collection.
Potassium	P	100	Acidify to between pH1 to 2 with HNO_3	1 month	
Purgeables by purge and trap	G, with PTFE cap liner	100	Acidify to between pH1 to 2 with H_2SO_4	7 days	14 days [c] If sample is chlorinated, for each 1000ml of sample add 80mg of $Na_2S_2O_35H_2O$ to the container prior to sample collection.
Selenium	P acid washed or G acid washed	500	Acidify to between pH 1 to 2 with HNO_3	1 month	
Silicates, dissolved	P	200	Cool to between 1ºC to 5ºC	1 month	The sample should be filtered on-site at the time of sampling
Silicates, total	P	100	Cool to between 1ºC to 5ºC	1 month	
Silver	P acid-washed or G acid-washed	100	Acidify to between pH 1 to 2 with HNO_3	1 month	
Sodium	P or G	100	Acidify to between pH 1 to 2 with HNO_3	1 month	
Solids, suspended	P or G	500	Cool to between 1ºC to 5ºC	2 days	
Sulfate	P or G	200	Cool to between 1ºC to 5ºC	1 month	
Sulfide (easily liberated)	P	500 Fill container completely to exclude air	Cool to between 1ºC to 5ºC	1 week	Fix samples immediately on-site by adding 2ml of 10% (mass concentration) of zinc acetate solution. If the sample is chlorinated, for each 100ml of sample add 80mg of ascorbic acid to the container prior to analysis.
Sulfite	P or G	500 Fill container completely to exclude air		2 days	Fixing on-site by addition of 1ml of a 2.5% (by mass) solution of EDTA per 100ml of sample
Surfactants, anionic	G, rinse with methanol	500	Acidify to between pH1 to 2 with H_2SO_4 Cool to between 1ºC & 5ºC	2 days	Glassware should not be detergent washed. Can by combined with non-ionic.
Surfactants, cationic	G, rinse with methanol	500	Cool to between 1ºC & 5ºC	2 days	Glassware should not be detergent washed.
Surfactants, non-ionic	G	500 Ensure container is filled completely	Add 37% (by volume) formaldehyde (see WARNING at end of table) solution to give 1% (by volume) solution; cool to between 1º & 5ºC	1 month	Glassware should not be detergent washed
Tin	P acid-washed or BG acid washed	100	Acidify to between pH1 to 2 with HCl	1 month	
Total hardness	See "Calcium"				
Total solids (total residues, dry extract)	P or G	100	Cool to between 1ºC	24h	

eterminand to be studied	Type of container [a]	Typical volume (ml) and filling technique [b]	Preservation technique	Maximum recommended preservation time before analysis after preservation	Comments
			and 5ºC		
Trihalomethanes	G, vials with PTFE-faced septum	100 Fill container completely to exclude air	Cool to between 1ºC and 5ºC	14 days	If sample is chlorinated, for each 100ml of sample, add 8mg of $Na_2S_2O_35H_2O$ to the container prior to sample collection.
Turbidity	P or G	100	Cool to between 1ºC and 5ºC Keep samples stored in the dark.	24 h	Preferably carried out in the field
Uranium	P acid washed or BG acid washed	200	Acidify to between pH1 to 2 with HNO_3	1 month	
Vanadium	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	
Zinc	P acid washed or BG acid washed	100	Acidify to between pH1 to 2 with HNO_3	1 month	6 months [c]

WARNING – Beware of formaldehyde vapours. Do not store large numbers of sample in small work areas.

[a] P = Plastics (e.g. polyethylene, PTFE (polytetrafluoroethylene), PVC (polyvinyl chloride), PET (polyethylene terphthalate)

G = Glass

BG = Borosilicate glass

[b] The volume is indicative for a single test

[c] Validate prolonged preservation times

[d] Not recommended for simultaneous persulfate oxidation/digestion procedures

APPENDIX E

MARINE BIOLOGICAL SAMPLES – CONTAINERS, PRESERVATION AND STORAGE

The following is taken from ISO 5667-3:2003 – Water Quality – Sampling – Part 3: Guidance on the Preservation and Handling of Water Samples and shall apply to biological samples collected during marine surveys.

Determinand to be studied	Type of container [a]	Preservation technique	Typical volume (ml)	Maximum recommended preservation time before analysis [b]	Comments
Benthix macro-invertebrates, large samples	P or G	Add ethanol to the sample to give concentration of at least 70% (volume fraction)	1000	1 year	Water in samples should first be decanted to maximise the preservative concentration
	P or G	Add 37% formaldehyde (see WARNING at end of table) neutralised with sodium tetraborate or hexamethylene-tetramine (100g/l formalin solution) to give a final solution of 3.7% formaldehyde (corresponding to a 1 in 10 dilution of formalin solution)	1000	1 years (3 months minimum preservation time before analysis)	
Benthic macro-invertebrates, small samples (form example reference collections)	G	Transfer to a preservative solution consisting of at least 70% by volume ethanol, 37% by volume formaldehyde (see WARNING) and glycerol (in the proportions 100:2:1 respectively)	100	Indefinitely	Special methods are required for invertebrate groups that are distorted by normal preservative treatment (for example platyhelminthes)
Algae	G or P with tight fitting lid	Addition of 0.5 part to 1 part by volume of (acid or alkaline) Lugol's solution to 200 parts by volume of sample. Cool to 1ºC to 5ºC	200	6 months	Keep samples stored in the dark. Alkaline Lugol is generally applicable in freshwater and acid Lugol in marine water with delicate flagellates. For specific determination see specific standard. Additional of more Lugol's solution may be necessary if decolourisation occurs.
Phytoplankton	G	See "Algae"**	200	6 months	Keep samples in the dark
Zooplankton	P or G	Addition of 37% by volume formaldehyde (see WANRING) neutralised with sodium borate to give final solution of 3.7% formaldehyde or addition of Lugol's solution as for algae.	200	1 year	Addition of more Lugol's solution may be necessary if decolourisation occurs.

WARNING – Beware of formaldehyde vapours. Do not store large numbers of sample in small work areas.

[a] P = Plastics (e.g. polyethylene, PTFE (polytetrafluoroethylene), PVC (polyvinyl chloride), PET (polyethylene terphthalate)

G = Glass

BG = Borosilicate glass