Annex 1: Challenges and opportunities for industry sectors

In recognition of the opportunity for environmental science to be used for innovative monitoring approaches across a range of sectors, this cross-cutting call is run as part of the NERC Environmental Risks to Infrastructure Programme (ERIIP), the Innovation Programme in Oil and Gas (IPOG) and pump-priming for a potential future innovation programme in offshore renewable energy (ORE)[1].

Across these sectors, there is the opportunity to utilise the latest technologies, techniques and tools, to more accurately monitor the environment and its interactions with assets and operations. In turn, enabling industry and 'end-users' to meet drivers related to:

- reducing costs and personnel time;
- enabling operation in extreme and challenging environments where it is unsafe/not possible for human workers to do so (such as sub-surface, sub-sea, disaster response areas);
- minimising disruption to operation of assets;
- gaining greater time and spatial resolution information to enable more informed decisions;
- monitoring of prospective, operational and/or decommissioned sites for consenting or regulatory requirements; and
- informing design standards of assets and how they are operated.

An overview of each of the Innovation Programmes and example challenge and opportunity areas of interest to each of these sectors are outlined below.

The challenges facing these sectors are often similar, however different sectors may take different approaches or techniques. Proposals which address challenges across sectoral boundaries, or which transfer approaches across sectors, are encouraged.

Environmental Risks to Infrastructure

The Environmental Risks to Infrastructure Programme (ERIIP) is focussed on three themes (below) and looks at a wide range of environmental hazards and their impacts on the infrastructure system (e.g. flooding, wind, sea level rise, landslides, space weather).

Theme 1: Identifying, understanding and quantifying environmental risks to the infrastructure system.

Theme 2: Likelihood, effect and impact of multi-hazard combinations on the infrastructure system.

Theme 3: Dealing with uncertainty in design, operational and investment decisions.

Areas of interest across the ERIIP members include (but are not limited to) the use of monitoring for:

- Assessments of asset integrity to enable infrastructure owners/operators to focus at the most vulnerable zones, enabling preventative action or direct more focused/intensive monitoring activity.
- Early warning of damage to assets, so that action can be taken to prevent more extensive damage and limit disruption to infrastructure.

[1] NERC Innovation Programmes are five-year, £5m initiatives which brings together academia with industry, regulators and policy-makers to enable access to data, knowledge and expertise in the UK environmental science research base. The Programmes operate according to the following general principles: end-user - challenge led; open competition; translation-focused and impact driven.

- To inform design standards of infrastructure so that it is more resilient to environmental hazards.
- To provide site specific information for operators to inform weather windows and timing of maintenance.
- Devising more robust and quantitative measurements to assess environmental hazards and their impacts on assets. (Often proxies are used because they are easier to measure or qualitative (often visual) judgements are made of the state of infrastructure leaving them open to opinion and bias).

Details of ERIIP industry members including their areas of interest and contact details are detailed in the ERIIP Members Challenges document, available on the NERC website alongside the current 2017 ERIIP Innovation Projects Call.

Oil & Gas

The Innovation Programme in Oil and Gas (IPOG) is focused around four priority themes:

- **Decommissioning** – The UK Continental Shelf (UKCS) is one of the world's most mature petroleum provinces with many assets (oil and gas platforms and associated wells, pipelines and other subsea structures) reaching the end of their field lives and likely to require decommissioning over the next 30 years. This task must be conducted in a safe and responsible manner, in one of the harshest maritime environments.
- **Extending the life of mature basins** – Mature basins such as the UK's North Sea contain very significant amounts of unrecovered hydrocarbons. Identifying and producing new resources in a cost-effective and environmentally sensitive way is technically challenging.
- **Exploration in challenging environments** – Large oil and gas resources are still present in environments in which exploration, appraisal and production are challenging, and where conventional technologies are inadequate.
- **Unconventional hydrocarbons** – Unconventional oil and gas (e.g. shale oil and gas resources) is an important part of the energy debate. Environmental science can provide independent evidence and expertise on the feasibility and safety of these resources, and inform industry's efforts to boost its efficiency and manage its environmental impact.

Proposals are welcomed which address monitoring challenges and opportunities relating to any of the above themes. Areas of interest include (but are not limited to):

- Establishing environmental baselines (or proxies for these).
- Producing guidelines/codes of conduct e.g. for benthic sampling in Marine Protected Areas.
- Assessing cumulative impacts at the regional and field level – e.g. enabling comparison across projects, areas, habitats, understanding of population level impacts, cross-sector approaches for oil and gas and offshore renewable energy developments.
- Long-term post development seabed monitoring to provide a regional view to: assist in the understanding of the changing environment around developments; highlight or track impacts (or point towards other inputs / impact sources); and enable an understanding of the implications of such impacts to assist with the development of future decommissioning plans.
- Mapping/understanding the sub-surface e.g. broadband and time-lapse (4-D) seismic to improve subsurface imaging of aquifers and reservoirs, potential petroleum repositories or for potential use a carbon storage sites; or micro-seismic monitoring for unconventional hydrocarbons.

- In-well surveillance solutions for sub-sea completions (e.g. using fibre-optics).
- New or emerging technology for remote methane sensing (land, airborne and satellite) and leak detection using infrared cameras.

Offshore Renewable Energy

NERC is currently scoping a potential future innovation programme in offshore renewable energy (ORE) and what the potential priority themes of this might be.

Proposals are welcomed which address monitoring challenges and opportunities relating to offshore renewable energy, including (but not limited to):

- Increasing baseline understanding of marine ecosystems – reducing uncertainty and increasing environmental baseline understanding, for example related to: characterisation of e.g. tidal sites (3D flow structure and turbulence), benthic macro fauna, diadromous fish species; harnessing technologies that could give a wider network of observations of environmental variables, especially on fine temporal scales; development of automated processing of aerial survey images/ video data to detect features (e.g. birds, marine mammals, vessels).
- Detecting impacts and avoidance behaviour – methods to monitor and detect impacts and avoidance behaviour of marine species in response to offshore renewables development including the consideration of cumulative impacts, and potential effects and consequences of displacement.
- Assessing population level impacts – assessing the population level consequences of marine renewables development on marine species.
- Understanding mitigation options – understating the efficacy of mitigation measures for use in areas of marine renewable development, including e.g. assessing the efficacy of mitigations measures across marine industry sectors including development of joint codes of best practice.
- Monitoring of biofouling/corrosion of critical sub-sea technology components and structures – particularly in remote and high energy locations.