EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

DIRECTORATE D - Nuclear Energy
Radiation Protection

TECHNICAL REPORT

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35 OF THE EURATOM TREATY

SELLAFIELD NUCLEAR REPROCESSING PLANT

LILLYHALL VERY LOW LEVEL RADIOACTIVE WASTE REPOSITORY

CUMBRIA
UNITED KINGDOM

23 to 25 August 2011

Reference: UK-11/07

VERIFICATIONS UNDER THE TERMS OF ARTICLE 35
OF THE EURATOM TREATY

FACILITIES:	Installations for off-site surveillance of the environment during normal operations of the Sellafield Nuclear Fuel Reprocessing Plant Installations for monitoring and controlling liquid radioactive effluent discharges from the Lillyhall Very Low Level Radioactive Landfill Site.
LOCATIONS:	Sellafield, Cumbria, United Kingdom Lillyhall, Cumbria, United Kingdom
DATE:	23 to 25 August 2011
REFERENCE:	UK-11/07
INSPECTORS:	Finlay MacLean (Head of team) Alan Ryan
DATE OF REPORT:	27.09.2012

SIGNATURES:

Finlay MacLean Alan Ryan

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ABBREVIATIONS

BeGe	Beryllium window Germanium (radiation measurement)
BNFL	British Nuclear Fuels plc
BNGSL	British Nuclear Group Sellafield Limited
BPM	Best Practicable Means
BPT	Break Pressure Tank
BST	BST (British Summer Time)
CA	Certificate of Authorisation
CEAR	Compilation of Environment Agency Requirements
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFA	Conditions For Acceptance
CoP	Code of Practice
DECC	Department of Energy and Climate Change
DG ENER	Directorate General Energy (of the European Commission)
DOS	(Microsoft) Disk Operating System
DTI	Department of Trade and Industry
EA	Environment Agency
EC	European Commission
EHS	Environment and Heritage Service for Northern Ireland (Now Northern Ireland Environment Agency (NIEA)
EMA	Environmental Monitoring and Assessment group (BNFL)
EMP	Environmental Monitoring Programme
EPR 2010	Environmental Permitting Regulations, 2010
EU	European Union
FIDLER	Field Instrument for Detecting Low Energy Radiation
FSA	Food Standards Agency
GDL	Generalised Derived Limit
GM	Geiger-Müller (radiation measurement)
HMIP	Her Majesty's Inspectorate of Pollution (now Environment Agency)
HPGe	High Purity Germanium (radiation measurement)
HV-VLLW	High Volume Very Low Level Waste
ISO	International Standardization Organization
JRC	Joint Research Centre (DG of the EC)
LEGe	Low Energy Germanium (radiation measurement)
LGC Ltd	Laboratory of the Government Chemist Ltd
LLD	Lower Limit of Detection
LOD	Limit Of Detection
LSC	Liquid Scintillation Counter
LSN	Laboratory Sample Number
LWR	Light Water Reactor
MAFF	Ministry of Agriculture, Fisheries and Food (now DEFRA)
MCERTS	Monitoring Certification Scheme
MDA	Minimum Detectable Activity
NaI(Tl)	Sodium Iodide, Thallium activated (radiation measurement)
NAMAS	National Measurement Accreditation Service (replaced by UKAS)
NDA	Nuclear Decommissioning Authority
NIEA	Northern Ireland Environment Agency
NIA	Nuclear Installations Act 1965 (as amended)

NII	Nuclear Installations Inspectorate
NRPB	National Radiological Protection Board
ONR	Office for Nuclear Regulation
QAAM	Quality Assured Analytical Method
QA	Quality Assurance
QNL	Quarterly Notification Level (of radioactive discharge)
RAL	Rolling Annual Limit
REM	Radioactivity Environmental Monitoring (EC data base at JRC Ispra)
RIFE	Radioactivity In Food and the Environment (report)
RMA	Radiological Monitoring and Assessment (team within the Nuclear Regulatory Group of the Environment Agency)
RMSWG	Radiological Monitoring Standards Working Group
RQNL	Rolling Quarterly Notification Levels
RSA 93	Radioactive Substances Act, 1993
SEPA	Scottish Environment Protection Agency
SSP	Sellafield Site Procedure
SL	Sellafield Limited
SLC	(nuclear decommissioning) Site Licence Company
TID	Technical Implementation Document
TLD	Thermo-luminescence Dosimetry (radiation measurement)
UK	United Kingdom
UPS	Uninterruptible Power Supply
UKAS	United Kingdom Accreditation Service
VLA	Veterinary Laboratory Agency
WQCL	Waste Quality Checking Laboratory (of the EA)

1 INTRODUCTION

Article 35 of the Euratom Treaty requires that each Member State shall establish the facilities necessary to carry out continuous monitoring of the levels of radioactivity in air, water and soil and to ensure compliance with the basic safety standards [(1)]. Article 35 also gives the European Commission (EC) the right of access to such facilities in order that it may verify their operation and efficiency. The Radiation Protection Unit (ENER D.4) of the EC's Directorate-General for Energy (DG ENER) is responsible for undertaking these verifications.

The main purpose of verifications performed under Article 35 of the EURATOM Treaty is to provide an independent assessment of the adequacy of monitoring facilities for:

- Liquid and airborne discharges of radioactivity into the environment by a site (and control thereof).
- Levels of environmental radioactivity at the site perimeter and in the marine, terrestrial and aquatic environment around the site, for all relevant pathways.
- Levels of environmental radioactivity on the territory of the Member State.

Taking into account previous bilateral protocols, a Commission Communication[2] was published in the Official Journal on 4 July 2006 describing practical arrangements for the conduct of Article 35 verification visits in Member States.

For the purpose of such reviews, on several occasions verification teams from the EC have visited the Sellafield site, which is located on the coast of Cumbria in northern England, UK. At the time of the present verification, ownership of the site had been transferred to the Nuclear Decommissioning Authority (NDA), which had contracted out site operation to Sellafield Ltd, a nuclear decommissioning Site License Company (SLC). Thus Sellafield Ltd is the site licence holder.

The verification visit focussed upon Sellafield Ltd's programme for monitoring of levels of environmental radioactivity in the marine, terrestrial and aquatic environment around the site as well upon the independent environmental monitoring programme implemented by the Environment Agency and the Food Standards Agency). Within the UK, the EA's remit is limited to England & Wales. The Northern Ireland Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA) also independently monitor environmental radioactivity arising from Sellafield discharges, however time did not permit the inclusion of these programmes in the verification's scope.

It should be noted that, in relation to the Sellafield site, only the off site environmental monitoring programme was covered by this verification. For information about the on-site programme and in particular airborne and aqueous discharge monitoring, please consult the report on the 2010 Article 35 verification of Sellafield, reference UK10/05.

2 PREPARATION AND CONDUCT OF THE VERIFICATION

2.1 PREAMBLE

The EC's decision to request the conduct of an Article 35 verification was notified to the UK Government on 15 April 2011 (reference ener.ddg2.d.4(2011)399135, addressed to the UK Permanent Representation to the European Union). The UK Government subsequently designated the Department of Energy and Climate Change (DECC) to lead the preparations for this visit.

[1] Council Directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation (OJ L-159 of 29/06/1996)

[2] Commission Communication Verification of environmental radioactivity monitoring facilities under the terms of Article 35 of the Euratom Treaty. Practical arrangements for the conduct of verification visits in Member States. (OJ C 155, 4.7.2006, p. 2–5)

2.2 DOCUMENTS

In order to facilitate the work of the verification team, a package of information was supplied in advance by the UK authorities. Additional documentation was provided during and after the visit. All documentation received is listed in Appendix 1 to this report. The information thus provided has been extensively used for drawing up the descriptive sections of the report.

2.3 PROGRAMME OF THE VISIT

The EC and the Department of Energy and Climate Change (DECC) discussed and agreed upon a programme of verification activities, with due respect to the 1993 Protocol (memorandum of understanding) between the UK authorities and the EC and the Commission Communication of 4 July 2006 setting out practical arrangements for the conduct of Article 35 verification visits. During the opening meeting presentations were given on the following topics:

- Government approach to nuclear sites
- The Sellafield site – introduction
- Off-site environmental monitoring at Sellafield (including radioactive particles).
- Groundwater monitoring at Sellafield
- EA/FSA independent monitoring programmes
- Environmental monitoring at Lillyhall landfill site

The verification team notes the quality and comprehensiveness of all presentations made and documentation provided.

The verifications were carried out in accordance with the programme in Appendix 2.

2.4 REPRESENTATIVES OF THE UK COMPETENT AUTHORITIES, THE OPERATOR AND ASSOCIATED LABORATORIES

During the visit the following representatives of the national authorities, the operator and other parties involved were met:

Nuclear Decommissioning Authority (NDA):

P. Edge

Environment Agency (EA):

I. Parker

Dr R. Allott	Sellafield Team Leader
S. Tandy	Nuclear Regulator
D. Batey	Nuclear Regulator

Food Standards Agency (FSA):

Dr. S. Runacres

Sellafield Limited:

J. Desmond Environmental Monitoring & Assessments Manager
S. Burns

Cefas:

C. Gough

Environmental Scientifics Group:

R. Benzing Head of Nuclear Chemistry

Health Protection Agency:

D. Hammond

Waste Recycling Group/Energy Solutions:

B. McMeekin	Technical Manager WRG
R. Scott	Director of projects Energy Solutions
A. Ryan	Development Director

Babcock Environmental Laboratory:

M. Froggatt	Laboratory Operations Manager
J. Bell	Technical & Quality Manager

The verification team acknowledges the co-operation it received from all individuals mentioned.

3 COMPETENT AUTHORITIES & LEGAL BACKGROUND

3.1 INTRODUCTION

Until April 2010 within England, Wales and Scotland, the Radioactive Substances Act 1993 (RSA 93) provided the framework for controlling the generation and disposal of solid, liquid and gaseous radioactive waste, including monitoring of the environmental impact of such disposal. As of April 2010, RSA 93 has been replaced in England and Wales by the Environmental Permitting Regulations 2010 (EPR 2010). In accordance with the provisions of these Regulations, the Environment Agency requires nuclear site operators with significant radioactive waste discharges to undertake monitoring of the environment on and around their sites. The Environment Agency also commissions independent monitoring of the environment and of radioactive waste discharges, thereby providing a check on the adequacy and the results of operators' monitoring programmes.

The Environment Agency's remit covers England and Wales. The EA is an Executive Non-Departmental Public Body responsible to the Secretary of State for Environment, Food and Rural Affairs for its activities in England and to the Welsh Government's Minister for Environment and

Sustainable Development for its activities in Wales. Despite being under the political responsibility of these Ministers, the EA is not integrated into the Ministries, and operates under the control of a Board.

The Food Standards Agency (FSA) is responsible for food safety and food hygiene across the whole UK. This responsibility is exercised in close cooperation with the Northern Ireland Environment Agency (NIEA) and the Scottish Environmental Protection Agency (SEPA) insofar as Scotland and Northern Ireland are concerned. The FSA is a non-ministerial government department created by the Food Standards Act from the fusion of services within the Department of Health and the then Ministry of Agriculture, Fisheries and Food. The FSA is not under the direct managerial control of a Minister, being managed by a Board.

The FSA's responsibilities include ensuring that any radioactivity present in foods does not compromise food safety and checking that any public exposure as a result of consumers' diet is within Euratom dose limits. The monitoring undertaken by the FSA is independent of the monitoring programmes carried out by nuclear site operators in accordance with their permits to discharge radioactivity.

The respective responsibilities of the FSA and the EA in relation to monitoring of environmental radioactivity are set out in the Working Together Agreement between them which covers the implementation of EPR 2010.

The distribution of responsibilities is as follows:

- Effluent monitoring — Environment Agency
- Environmental monitoring for non-food pathways — Environment Agency
- Food chain monitoring — Food Standards Agency

The Office for Nuclear Regulation (previously the Nuclear Installations Inspectorate) independently monitors direct radiation at nuclear sites. The results are taken account of in critical group dose assessments undertaken by the Environment Agency or the Food Standards Agency.

3.2 CERTIFICATES OF AUTHORISATION

The disposal of radioactive waste from nuclear establishments in England and Wales is authorised, subject to limitations and conditions set out in the permits granted by the Environment Agency under RSA 93 or EPR 2010. The permits determine the conditions and limits for the amount of radioactive substances discharged in solid, aqueous or gaseous form from each licensed site. Failure to comply with permits is an offence. Permits to discharge nuclear waste in accordance with RSA 93 or EPR 2010 are independent of permits to operate nuclear installations under the Nuclear Installations Act.

Limits are expressed both as gross alpha and beta values and as nuclide-specific values that may be discharged over specific periods of time. All permits include conditions governing record keeping, the use of best practicable means to reduce the activity in all the waste discharged, and the means of discharge. Also included are provisions for monitoring programmes, including environmental monitoring and analysis. Detailed provisions on monitoring are set out in the accompanying Compilation of Environment Agency Requirements (CEAR) documents.

The Environment Agency is responsible for granting permits. Prior to the adoption of EPR 2010, the Food Standards Agency had been a statutory consultee in the process of determining radioactive waste discharge authorisations, since then however consultation is no longer statutory, but rather is undertaken through a Working Together Agreement between the FSA and the EA.

At time of the visit, permit reference KP3690SX, dated 01/08/2011 and issued under EPR 2010 was applicable. The preceding Permit (reference BX9838/CE1369) was issued under RSA 93.

3.3 INDEPENDENT VERIFICATION BY THE REGULATOR

The Environment Agency, the Food Standards Agency, the Northern Ireland Environment Agency, and the Scottish Environment Protection Agency jointly publish an annual assessment of doses to the UK public from radioactivity in food and in the environment, based on the results gathered under their

respective environmental monitoring programmes. The report is known as RIFE (Radioactivity in Food and the Environment) and is published on the websites of the four commissioning agencies.

Additionally, SEPA, EA and FSA have jointly published a guidance note[3], aimed at operators and regulators, on planning and implementing routine environmental monitoring programmes. The guidance was developed by the Radiological Monitoring Standards Working Group (RMSWG). The RMSWG has representatives from the EA, SEPA, the FSA, the NDA, the nuclear industry, and monitoring experts.

4 THE SELLAFIELD SITE – SHORT DESCRIPTION OF PLANTS

The Sellafield site (including the former Windscale site) is owned by the Nuclear Decommissioning Authority (NDA) which has contracted out operation of the site to Sellafield Ltd , the site licensee. The chief activities carried out at Sellafield site are reprocessing nuclear fuel of various origins, decommissioning of old installations and managing nuclear waste from historical operations. The principal operational plants on the site are described below.

4.1 THERMAL OXIDE REPROCESSING PLANT THORP

The Thermal Oxide Reprocessing Plant (THORP) was developed in the early 1970's to reprocess spent oxide fuels from Advanced-Gas Cooled and Light-Water Reactors (LWR). The plant consists of three main areas: Receipt and Storage, Head End and Chemical Separation.

The main aerial effluents from THORP are monitored, sampled for analysis, and discharged to the atmosphere via the THORP stack.

4.2 ENHANCED ACTINIDE REMOVAL PLANT (EARP)

The Enhanced Actinide Removal Plant (EARP) was designed specifically to remove alpha activity and to reduce beta activity from liquid effluent streams resulting from historical and future reprocessing operations. These effluent streams contain iron in solution that on addition of sodium hydroxide in EARP forms a ferric floc.

Having precipitated the ferric floc (which contains most of the plutonium and alpha activity) from the feed liquors, an ion exchange reagent is added which removes mainly caesium from solution in the floc. The floc is dewatered by ultrafiltration to produce a final floc for encapsulation with cement in 500 litre drums in the Waste Packaging and Encapsulation Plant. The remaining permeate is sampled and sentenced prior to sea discharge.

4.3 SEGREGATED EFFLUENT TREATMENT PLANT (SETP)

The Segregated Effluent Treatment Plant (SETP) is designed to handle low risk, low active acidic and alkaline effluents arising from THORP and Magnox reprocessing operations, in addition to other feeds from across the site.

The acidic effluents are made alkaline by the addition of sodium hydroxide prior to mixing with the alkaline stream. The combined effluent is filtered to remove debris prior to transfer to one of three SETP sea tanks where it is proportionally sampled and sentenced prior to discharge to sea.

4.4 BREAK PRESSURE TANK (BPT)

The Break Pressure Tank (BPT) receives effluent streams from plants on site (e.g. SETP and EARP) and the combined effluent is discharged from the BPT to sea through Sea Line 3. Normally all low or

[3] Radiological Monitoring Technical Guidance Note 2, Environmental Radiological Monitoring, Version 1.0,December 2010

trace active liquid effluent discharged from the Sellafield site, apart from the lagoon effluent, passes through the BPT.

4.5 SELLAFIELD MOX PLANT

Designed to produce mixed oxide, or MOX fuel i.e. a blend of plutonium and natural or depleted uranium, the Sellafield MOX Plant closed on 3 August 2011.

4.6 MAGNOX REPROCESSING PLANT

In 1964 the Magnox reprocessing plant came on stream to reprocess spent nuclear fuel from the Magnox reactors. [1]The plant uses the "plutonium uranium extraction" Purex method for reprocessing spent fuel, with tributyl phosphate as an extraction agent producing uranium, plutonium and fission products as output streams

4.7 RADIOACTIVE WASTE STORES

Sellafield has a number of radioactive waste stores, mostly operated on an interim basis while a national waste repository plan is being developed and implemented. The stores include:

- Legacy Ponds and Silos - Storage of historic waste
- Sludge packaging plant - Treatment and interim storage of sludges from legacy ponds
- Sellafield product and residue store - Site store for product residues
- Engineered drum stores - Site stores for plutonium contaminated material
- Encapsulated product stores - Site stores for grouted wastes
- Vitrified product store - Vitrified high level waste

The UK's main Low Level Waste Repository is 6 km south east of Sellafield at Drigg.

5 THE ENVIRONMENTAL RADIOACTIVITY MONITORING PROGRAMMES

5.1 INTRODUCTION

In essence the effects upon the environment of site discharges are subject two principal monitoring programmes:

the operator's own programme

the regulators' monitoring programmes, and particularly those of the EA and the FSA

One of the conditions of the permit to discharge radioactive effluents and wastes is that an environmental monitoring programme (EMP) must be established in order to determine the effects of discharges on the environment. The primary purpose of such a programme is to monitor the safety of the general public and critical groups. The EMP also provides reassurance that permitted discharges are estimated correctly and that unusual discharges to the environment are recognised early.

In order to assess the total radiation dose received by a member of the public and for comparison with dose limits, samples are taken from the environment and the food chain. In this context the term sampling includes the collection of samples from the environment for laboratory analysis, and also selective direct measurements of dose rate in the environment to assess external exposure pathways. Most sampling and direct monitoring is conducted in the immediate vicinity of Sellafield, although the Ravenglass Estuary some 10 km south of the Sellafield site is also closely monitored. The Environment Agency’s monitoring programme for Sellafield’s discharges extends to the coast of Lancashire and North Wales.

5.2 SELLAFIELD LTD.

One of the objectives of the operator's EMP is to demonstrate that the allowed discharges have a minimal effect on the most exposed members of the critical group and that the dose to the public remains below the dose limit of 1 mSv per year. Only the operator's off-site environmental monitoring programme was included in this verification.

In parallel to the operator programme, the competent authorities run complementary EMPs, partly with the aim of verifying the operator's results.

5.3 ENVIRONMENT AGENCY MONITORING PROGRAMMES

The Environment Agency carries out the following routine monitoring programmes:

- Monitoring of effluent samples provided by nuclear site operators
- Monitoring of the environment, primarily in the vicinity of nuclear sites
- Waste quality checking of low level radioactive waste disposals
- Air and rainwater in the United Kingdom (on behalf of DECC)
- Drinking water sources in England and Wales (on behalf of DECC).

The Environment Agency also has an ad-hoc reactive monitoring programme that is available to undertake sampling and monitoring in support of specific investigations.

All the Agency programmes are managed by the Agency's Radiological Monitoring and Assessment team (RMA team) within the Nuclear Regulation Group. An Agency Management System procedure for 'Routine Radiological Monitoring' has been developed.

The monitoring programmes are specified through liaison with Environment Agency Nuclear Regulators (who are responsible for regulating the permitted premises) and RMA team Programme Managers. The programmes are tailored to the individual site permits with regard to what types of samples are collected and nuclides analysed.

However, where there is commonality the programmes are designed to be consistent. The required samples/nuclides and detection limits are specified in the monitoring programme contracts. These programmes are then competitively tendered.

To ensure the standard of the monitoring data the Environment Agency requires the contractors it uses for its monitoring programmes to be accredited by the UK Accreditation Service (UKAS) to ISO 17025. Furthermore, the Environment Agency has set up the Monitoring Certification Scheme (MCERTS) which aims to deliver quality environmental measurements through the approval of people, instruments and laboratories. Under this scheme a performance standard for the radio-analytical testing of environmental and waste waters is being developed, which will then be used in conjunction with UKAS accreditation. EA's contractors are required to hold procedures available for inspection at their laboratories. Additionally, contractors are required to take part in national and/or international inter-comparison exercises.

5.3.1 Environmental Monitoring (nationwide)

The Environment Agency undertakes a programme of monitoring of radioactivity in the environment, where the radioactivity could lead to exposure of the public from non-food pathways such as might arise from the occupation of beaches, river banks or other areas. The programme consists of surveys of gamma dose rates and contact beta/gamma dose rates at specified locations and laboratory analysis of radionuclide concentrations in environmental samples taken from specified locations in the vicinity of nuclear sites and other industrial premises.

The main environmental sample types analysed (and reasons for sampling and analysis given by the EA) are as follows:

- Sediment - These are a potential source of exposure through external radiation, inhalation and inadvertent ingestion during recreational activities. Results are also used for the validation of reported discharges and sea dispersion modelling.
- Seaweed - Good indicator of recent discharges, less transient than seawater, but not as long as sediment. More homogenous than sediment. Particularly good indicator for certain radio-nuclides (e.g. iodine and technetium).
- Seawater - Precursor to incorporation of radio-nuclides in sediment, fish and shellfish. Results also used for the validation of reported discharges and sea dispersion modelling.
- Grass/Herbage - Food source for livestock which provide products for human consumption; a particularly important exposure pathway being milk. Results are also used for the validation of reported discharges and environmental transfer modelling. Detection of abnormal releases. Can be more sensitive than milk since cows graze larger areas.
- Soil - Important part of environmental transfer pathway to milk. Root zone (i.e. top few centimetres) is the relevant zone. Less variability than grass, thus better long term measure for state of the environment. Enables measurements of total deposition of long-lived radio-nuclides to be made. Important background measurement in case of incident.
- Gullypot (road drain) sediment - Enable detection of fugitive emissions, such as dust and contamination on vehicles.
- Natural water - Potential source of exposure through consumption of water, including inadvertent consumption during recreational activities. Indicator of abnormal releases and land contamination.
- Drinking water - Secondary consumption radiological exposure pathway.

Currently the monitoring of the above sample types is carried out by *Environmental Scientifics Group Limited* (Oxfordshire), in accordance with Agency specifications. Documented methods accredited by UKAS are employed.

The selection of sampling or measurement points is based on a combination of factors, including measured dose rates and the occupancy of the areas. Local habit surveys are also considered when defining the monitoring programme. The majority of monitoring is focused around the nuclear licensed sites.

Samples are normally taken quarterly and analysed by gamma ray spectrometry and in some cases, chemical extraction and separation followed by beta counting or alpha spectrometry. Sampling techniques are put down in respective procedures.

Measurements of gamma dose rates above beach, inter-tidal and river bank areas are made by measuring the absorbed dose rate in air (μGy/h) one metre above ground. A *Mini-Instruments Environmental Meter type 6-80* fitted with an energy-compensated Geiger-Müller tube type *MC-71* is used for this purpose.

Contact beta/gamma monitoring of debris at the most recent strand line on the beach or river bank is also carried out. A *Mini-Instruments series 900 mini monitor* with a beach monitoring probe is used for this purpose.

For fishing equipment (for example nets and pots) external beta doses are measured on contact, using *Berthold LB 1210B* contamination monitors. These portable instruments are calibrated against recognised reference standards. This work recently transferred from the FSA is undertaken by CEFAS for consistency.

5.3.1.1. Air and Rainwater

Routine measurements of radioactivity in air and rainwater have been carried out for many years in the UK. The results provide information on the activity concentrations of radio-nuclides in air and the levels of radioactivity deposited in rainwater. A detailed description of the programme and the results

are published annually. The results are provided to DECC for submission to the European Commission under Article 36 of the Euratom Treaty.

Currently this analysis is undertaken by the Health Protection Agency (Radiation and Environmental Monitoring), Glasgow, Scotland. Most methods used are accredited by UKAS. The seven sampling locations in the UK are Chilton (Oxfordshire), Aberporth (Dyfed), Conlig (County Down, Northern Ireland), Dishforth (Yorkshire), Eskdalemuir (Dumfriesshire), Lerwick (Shetland) and Orfordness (Suffolk). Airborne particulate material is sampled continuously at a height of about one metre above ground level. Filters are changed weekly at each location. The closest stations to Sellafield are Eskdalemuir and Dishforth on mainland Britain and Conlig in Northern Ireland.

All air and rainwater samples are analysed quarterly by gamma-ray spectrometry. Monthly analysis is carried out on air and rain samples from Chilton and rain samples from Aberporth. Where appropriate, additional samples are also analysed for tritium and/or plutonium and americium. The analytical methods used are laid down in the respective documents.

5.3.1.2. Drinking Water Sources

Regular monitoring of radioactivity in water sources (rivers, reservoirs and boreholes) used for the supply of drinking water has also been carried out for many years in the UK. The water companies provide samples of water for analysis. The analyses are undertaken by LGC Ltd, Teddington, using methods that are UKAS accredited. The results are also provided to DECC for submission to the European Commission under Article 36 of the Euratom Treaty. These results also provide information to the water companies on the activity concentrations of radio-nuclides in raw water sources and supplementary data to the Environment Agency on exposure of the public.

Samples of water are taken from 31 sources on a near-daily basis and bulked over three-month periods to provide “quarterly bulks” for analysis. The samples are analysed for total alpha and total beta activities and a range of specific radio-nuclides. Details of the analytical methods employed by the contractor LGC are laid down in respective documents.

5.3.2 Transmission of Monitoring Data and Records

The contractors who undertake the Environment Agency’s monitoring programmes have quality management procedures in place to provide an audit trail of results through to transmission to the Environment Agency. These procedures form part of the laboratories UKAS accreditations. Results are provided as a combination of electronic and paper reports to the Agency.

The Environment Agency holds an environmental radiological monitoring database that provides the repository for the Environment Agency’s monitoring data. This database was originally developed by *AEA Technology* in accordance with the 'TickIT' scheme. Further development has been undertaken by the RMA Team to enable direct electronic transfer of the data from the contractor to the database. A similar effluent monitoring programme database also exists which is the repository for the comparison results between the operator and our independent laboratory. This is annually updated, however on a quarterly basis results are distributed to the operators through a comparisons spreadsheet, to enable an on-going assessment of performance and any issues to be addressed.

5.3.3 Notification of Unusually High Results

There are various stages at which unusually high results could be identified and highlighted to the Environment Agency:

- Directly following sampling in the field, as samples from areas of previously known high activity are monitored for dose rate in the field.
- Following receipt of the sample at the contractor’s laboratory, where dose rate readings are taken on all samples.
- Directly following analysis where expert judgement is used to determine whether the activity is significantly above normal environmental levels. This judgement is not only based on

reviewing the actual results, but also takes into account detailed knowledge of other factors (local variation in sediment grain size and characteristics at a particular location).

- By utilising facilities in the environmental radiological monitoring database to look at action levels and trends. Action levels are calculated for each sample/location/radionuclide combination based on particular confidence levels associated with historical results (e.g. 99.9% which equates to 1 in 1000). Reports can be run to select those results for a particular year which exceed the appropriate action level.

Where results are considered "highly significant" the contract laboratory notifies the Agency Programme Manager immediately by e-mail/fax and usually by telephone also. This procedure is also followed for beach strandline contact beta/gamma monitoring when a "hot particle" is found. In such cases the Programme Manager immediately informs the relevant Agency Nuclear Regulator.

The action level facility of the database is also used to identify results which may not be "highly significant" but nevertheless are regarded as "interesting" or "noteworthy". Results exceeding the chosen action level can be listed or presented as graphs. Also the database allows trend graphs to be produced – either selecting a standard set or choosing an individual location, matrix and nuclide combination. Use of this system is still augmented by the use of experience and judgement.

5.4 FOOD STANDARDS AGENCY MONITORING PROGRAMMES

Nuclear sites are the prime focus of the Food Standards Agency monitoring programme with monitoring carried out close to each of the sites. Most food chain sampling and direct monitoring is conducted in the site's immediate vicinity. However, radio-nuclides (such as Tc-99) discharged in liquid effluent from Sellafield Ltd can be detected in the marine environment in many parts of north-European waters, hence the programme for this site extends beyond national boundaries.

The description of the work undertaken can be divided into two main categories: aquatic and terrestrial. The aquatic programme deals with contamination in or near the sea, rivers and lakes and acts as a check on disposals of liquid wastes. The terrestrial programme deals with contamination on land, which is dominated by disposals to the atmosphere. Work is also undertaken on general diet surveys in the form of canteen meals, which provide information on radio-nuclides in the food supply to the whole population.

The main aim of the programme is to monitor the diet of consumers who live or work near nuclear sites in order to estimate exposures for those small groups of people who are most at risk from disposals of radioactive waste. By identifying and monitoring the representative person (formally a critical group of consumers) who might potentially receive the highest dose and ensuring that this person does not exceed the EU dose limits, the Food Standards Agency strategy assumes that all other consumers in areas which have lower concentrations of radioactivity would also be protected. Using this strategy, the programme also serves to address the concerns of stakeholder groups and other Member States.

For the programmes samples are collected from the environment and analysed for their radio-nuclide content in a laboratory.

The analyses carried out on samples vary according to the nature of the radionuclide under investigation. The types of analysis can be broadly categorised in two groups: (i) gamma-ray spectrometry; and (ii) radiochemical methods. The latter are only used when there is clear expectation that information is needed on specific radio-nuclides.

Three laboratories analyse samples:

1. CEFAS - Centre for Environment, Fisheries and Aquaculture Science
    - Lowestoft Laboratory - Analysis of all aquatic samples;
    - Whitehaven Laboratory – Collection and some limited preparation of samples prior to their dispatch to the main laboratory at Lowestoft;
    - Collection of some terrestrial samples.

2. VLA - Veterinary Laboratory Agency, Surrey - Gamma spectrometry and radiochemistry of terrestrial samples.
3. HPA – Centre for Radiation, Chemicals and Environment, Didcot, Oxon – Analysis of canteen meal samples.

Each laboratory operates a quality control procedure to UKAS. Inter-comparison exercises are also undertaken with other laboratories in the UK and in Europe.

5.5 HEALTH PROTECTION AGENCY

Within the Health Protection Agency's Environmental Radioactivity Surveillance Programme samples of airborne dust and milk are collected routinely from selected locations within the UK, the Channel Islands and the Isle of Man and the activity concentrations of various nuclides are measured.

All the analyses and measurements are included within the relevant UKAS accreditation schedules.

5.6 CONTINUOUS GAMMA MONITORING

The RIMNET nuclear radiation monitoring and nuclear emergency response system is operated by the Meteorological Office on behalf of DECC. Set up in response to the Chernobyl accident, every hour the system collects radiation dose rate readings (gamma plus cosmic) from 96 sites around the UK.

Background radiation is the main component of observed levels of gamma radiation recorded at RIMNET sites. The observed UK annual radiation dose rate ranges from around 0.5 mSv to 1.0 mSv with an average of less than 0.7mSv. Measurement results can be downloaded from the DECC website (http://www.decc.gov.uk/en/content/cms/statistics/rimnet/rimnet.aspx)

RIMNET monitoring stations are normally located at some distance from nuclear sites, mainly in order to ensure that results are not sensitive to variations in authorised discharges from nuclear sites. As the focus of the verification exercise was site related environmental monitoring, RIMNET was not included in the scope of this verification exercise.

5.7 MONITORING AROUND THE SELLAFIELD AREA

5.7.1 Sellafield Ltd. –Operator's off-site monitoring programme

The operator's programme focuses on two main areas, terrestrial and marine monitoring, with the objective of quantifying potential doses to individuals, taking account of the data received from local population habit surveys. This is undertaken through direct measurement of dose rate and through analysis of environmental samples. The programme also defines levels of radioactivity in the environment for which immediate notification of the regulator is compulsory.

The media sampled in the operator's programme are:

- Milk (from 3 farms within 4 km radius)
- Vegetables (potatoes within 3 km radius)
-- Drinking water (5 population centres within 15 km radius)
- Surface water (rivers Calder, Eern and Lakes)
- Ground water on site
- Surface contamination (dose rate on 15 km of coastline)
- Seawater (15 km radius)
- Sand and mud
- Seaweed
- Fish, Crustacea and Molluscs (locally caught) –
  Meat, fruit and vegetables – data from the FSA programme is used)

Sellafield Ltd does not operate its own Environmental monitoring laboratory, the relevant tasks being assured by an external contractor (Babcock Nuclear Environmental Laboratory, based at the Westlakes Science and Technology Park).

5.7.1.1. Beach Radioactive Particles

Additionally, a special programme related to beach radioactive particles is implemented. Radioactive particles are known to have been released into the environment as a result of historical operations and events at the Sellafield nuclear site. Similar to the approach employed at Dounreay, a special vehicle, known as a "Groundhog" fitted with measuring devices. The Groundhog is fitted with five large volume NaI detectors spaced out over the vehicle's width as well as eight FIDLER (Field Instrument for Detecting Low Energy Radiation) probes optimised for detecting americium. Manual sampling along the strand line using gamma probes is also carried out.

Using this approach, it is possible to check around 300 hectares of beach per year, mostly the beaches at Sellafield and nearby Braystones although beaches on the Solway Firth in Scotland have also been checked. By the time of the visit around 1000 particles had been found – 40% of which were connected to stones. Monitoring is performed mainly in an area several kilometres north of Ravenglass where the public has access; (further south the area is a closed military area).

Sellafield Ltd stated that a typical americium particle would have an activity of around 20 kBq. Around 10% of the particles found are sent to the National Physical Laboratory for imaging and, where possible, for analysis.

Sellafield Ltd are also carrying out research on aerial detection of particles, but so far the results are not promising. In conjunction with the Environment Agency, Sellafield Ltd were also about to launch a project on underwater detection of radioactive particles.

The results of Sellafield Ltd's monitoring of beach particles are published on the internet (http://www.sellafieldsites.com/about-us/environment-health-safety--quality/environment/particles-in-the-environment). The Health Protection Agency has been tasked with studying the risk to the public from accessing the beaches around Sellafield (published on the HPA web-site (http://www.hpa.org.uk/Publications/Radiation/CRCEScientificAndTechnicalReportSeries/HPACRCE018/). The report concludes that the overall health risks for beach users are very low. It also recommends that regular monitoring be continued at Sellafield beach and at other nearby beaches with high public occupancy. Based on these findings, Sellafield Ltd will also continue regular monitoring of Drigg beach.

Unfortunately at the time of the visit, monitoring had been suspended due to the school holidays and this aspect could not be witnessed. (The request to suspend beach monitoring during the school holidays comes from local stakeholders).

5.7.2 Environment Agency Monitoring

The EA monitoring specific to the Sellafield area is within two of the main monitoring programmes; the environmental and effluent monitoring programmes.

The environmental monitoring consists of sampling of natural waters, reservoir supplies, sediments, seawater, seaweed and drainage gully pot sediments. Measurements of gamma dose rates and beta/gamma contamination levels are also made at several locations, with beta dose rates made at a few locations.

According to the information received, a recommendation arising from the Euratom Article 35 verification visit to the Dungeness area in November 2000 on the collection of independent samples was taken up by requiring the check monitoring contractor to witness operators collecting samples. EA judged that a risk-based approach should be adopted whereby samples for effluent discharges with low/negligible radiological impact need not be witnessed. This approach was also introduced for the Sellafield site. The Environment Agency conducted a review of the check monitoring programme to see how the witnessing element could be accommodated. Many samples are “spot” or “grab” samples taken at the time of a tank discharge – such samples are readily amenable to witnessing by the check

monitoring contractor. However, there are many samples which are "bulks" collected over a particular period of time (e.g. a calendar quarter); these samples are often collected automatically – e.g. by flow proportional sampler. Such samples could not be witnessed by the check monitoring contractor. As bulk samples serve an important purpose – they provide a measure of the radioactivity discharged over a particular time period – they have been retained on the programme, but they have been supplemented with witnessed spot samples from the key sites and effluent streams. The original intention was for the check monitoring contractor to take witnessed samples away with them on the day of sampling. However, EA recognised that this may not be feasible in some instances (e.g. due to the need for samples to be cleared through health physics checking procedures). Hence, the contractor carries a stock of tamper-evident numbered sealing clips which are used to seal bags containing the sample bottles once prepared. Operators are required to dispatch samples to the analytical laboratory as soon as possible after the day of sampling.

5.7.3 Food Standards Agency Monitoring

5.7.3.1. Sellafield Aquatic Programme

The main components of the Sellafield aquatic programme are sampling and laboratory analysis of a wide range of seafood and indicator materials. The frequency of measurement depends on the level of environmental impact from the source under scrutiny, with the intervals between measurements varying between 1 week and 1 year.

The types of material sampled and the locations from which samples are taken are chosen to be representative of existing exposure pathways. Knowledge of such pathways is gained from surveys of local peoples' diets and habits. The most recent comprehensive survey of habits for the Sellafield area was carried out in 2008, although minor reviews of habits are undertaken each year. As a consequence the scope of the programme varies from year to year, according to local circumstances. For example, in 2008 there was no reported consumption of uncommon seafood (such as sea mice) caught as a by-catch of fishing in the Sellafield area, although this practice has been observed in the past and the potential pathway is kept under review in case future habit surveys show that this practice has resumed.

5.7.3.2. Terrestrial Programme around Sellafield

The main focus of the terrestrial programme around Sellafield is the sampling and analysis of foodstuffs that may be affected by disposals to atmosphere, although in some cases where food availability is limited, environmental indicator materials such as grass are monitored.

The types of foodstuff sampled are chosen on a site-by-site basis to reflect local availability, and to provide information on: (i) the main components of diet; milk, meat and cereals, and (ii) products most likely to be contaminated by disposals, such as leafy green vegetables or soft fruit. Minor foods such as mushrooms and honey, which under certain circumstances are known to accumulate radioactivity, may also be sampled when available. The last comprehensive habit survey for Sellafield was undertaken in 2008 and changes were implemented to the sampling programme as required. Even minor pathways of radioactivity through the food-chain are monitored or estimated, for example the local consumption of vegetables grown in soil conditioned with seaweed, the dose due to the consumption of sheep grazing seaweed shores in the Scottish Isles and sea to land transfer of radioactivity in the Ravenglass area.

For monitoring purposes, cows' milk is generally the most important foodstuff as grass is an efficient collector of atmospheric contaminants, cows graze significant areas of grass in the summer months and many of the more important radio-nuclides are rapidly passed from grass into milk. Milk is also a convenient product to sample regularly and analyse and is an important part of the diet, especially for young children and infants. In addition, cows graze a large area of pasture and therefore the monitoring of milk provides a method of carrying out surveillance of large areas. For most analyses of milk, weekly or monthly collections are combined (bulked) to provide four quarterly samples for analysis each year, although some analyses may be carried out more frequently, such as weekly iodine-131 analysis. Quarterly bulking of some samples is carried out for analysis of tritium and C-14

and annually for caesium ratios. The frequency of analysis of other foodstuffs is generally annual. This allows for a wide range of sample types to be collected throughout the year. Samples are collected from locations as close to the sites as practicable as these are usually the most sensitive to the effects of disposals.

The Food Standards Agency also has an ad-hoc reactive monitoring programme that is available to undertake sampling and monitoring in support of specific investigations, for example if a site reported any unusually high discharges or incidents. Other monitoring is undertaken and results are reported in the relevant annual RIFE report as a result of specially commissioned research projects, for example Tc-99 in farmed salmon, or radioactivity in uncommon seafoods.

5.7.3.3. Reporting of results

The results of the Environment Agency and the Food Standards Agency from the monitoring programmes are published in annual reports. Since 2003, joint reports have been produced by the two Agencies: the most recently published report covers 2010 data. The joint reporting also incorporates monitoring undertaken in Scotland by the Scottish Environment Protection Agency (SEPA) and in Northern Ireland by the Northern Ireland Environment Agency (NIEA as well as information on direct radiation dose rates from the Nuclear Installations Inspectorate.

Results from the air, rainwater, public drinking water sources, milk and mixed diet monitoring are also supplied to DECC and forwarded to the European Commission for input to the REM database.

5.7.4 Monitoring by Other Agencies

Complementary monitoring in relation to Sellafield discharges is undertaken in Scotland by SEPA and in Northern Ireland by NIEA. These programmes were not included in the scope of the verification. The Health Protection Agency runs a limited programme of air monitoring at four locations around the UK, including an air monitoring station located inland of Seascale. Airborne dust is continuously at the latter location by drawing air through a polycarbonate filter at a flow rate of about 1 cubic metre per minute. Filters are changed fortnightly and bulked monthly for actinide analysis at the Health Protection Agency's Chilton laboratory. Measurements of Pu and Am are carried out using α spectrometry following chemical separation

6 VERIFICATION ACTIVITIES

6.1 SELLAFIELD LTD.

Not far from the Sellafield main gate there is a 50m meteorological tower, which would play a major role in emergency situations. In addition to the six ultrasonic wind speed measuring devices at 2, 4, 7, 10, 16 and 48m heights (there are duplicate devices at 10 and 48m), temperature and air pressure are measured at the four lowest heights. Solar radiation and rainfall are measured nearby.

The Sellafield site ^{85}Kr sampling station, operated by Babcock on behalf of Sellafield Ltd., is housed in a nearby secured building. Over a two week period, constant volume pumps draw one cubic metre air samples into each of two TEDLAR ® sample bags. The collected air is dried using silica gel.

In winter, heating prevents freezing of the sampled air and damage to the equipment. The power supply is shared with the meteorological tower and back-up power from a UPS is available in the event of a power cut. In addition to regular manual checks, and state-of-health is reported to the control centre.

Normally, only the contents of one sampling bag are analysed for ^{85}Kr by Babcock, but every second month the duplicate sample is also measured. From time to time samples are also analysed by the University of Ghent as a check on Sellafield Ltd's contractor. Sellafield Ltd state that good agreement is found between Babcock and University of Ghent measurement results.

The sample intakes, at a height of 1m80cm, point towards the site stacks. Sellafield Ltd state that discharge modelling shows that discharges from the site stacks are at ground level when they reach the site ^{85}Kr sampling station. Sellafield Ltd also state that measurement results correlate well with reprocessing campaigns and weather conditions.

Sellafield Ltd operate seven identical Ecotech high volume air samplers (HVAS) of which the verification team visited the ones located at Calder Bridge, Seascale beach and Whitehaven pier. All were housed inside protective cages. A further four units are held as spares and all are covered by a service contract with SamSys. The air sampling systems operate on controlled flow rate of 69 m^3/h (electronically controlled according to pressure and temperature). The pre-assembled 10×8-inch Whatman filter cartridges are normally checked weekly and changed monthly, but may be changed more frequently if needs be, as is the case at Seascale where salt loading can be a problem. Sampler flow rate is calibrated every three months and the samplers are calibrated every 12 months.

In addition the team also visited an automatic river water sampler, located next to the Calder Bridge HVAS and saw a demonstration of the taking of a water sample from the river. This sampler is located on the Calder River upstream of the Sellafield site and a second such sampler is located on the same river downstream of Sellafield site, just upstream of the tidal reach. The sampler is an off-the-shelf Aquamatic Aquacell Water Sampler. Ten one-litre samples per day are taken over thirty days and the sample bottle is refrigerated to protect against build-up of algae.

All the equipment visited was found to be in good condition and operating within the prescribed scheduled maintenance periodicities. No problems were found during spot sampling of the relevant maintenance, equipment control and sampling paperwork.

The verifications performed do not give rise to any recommendations or suggestions.

At the seafront car park in Nethertown the team were given a demonstration of mobile gamma measurement using 2 detectors placed 10m apart, 1 m above the ground for a counting time of 5 minutes. The measurements are made in accordance with a standard UK procedure (Her Majesty's Inspectorate of Pollution, Technical Guidance Note M5, Routine measurement of gamma ray air kerma rate in the environment). This activity would also routinely be carried out by the Environment Agency, however for the purposes of the verification, it was demonstrated by Sellafield Ltd personnel.

The verifications performed do not give rise to any suggestions.

6.2 FOOD STANDARDS AGENCY

The team witnessed winkle collection along a rocky area on Nethertown strand and subsequent preparation of the sample at the CEFAS building in Whitehaven, CEFAS being subcontracted to carry out the collection and subsequent analysis. The winkles were boiled in "artificial" seawater before being removed from their shells in order to replicate their preparation by consumers. The prepared sample is frozen and subsequently shipped to CEFAS Lowestoft for analysis. Records of samples are kept in both paper form and on computer and give full details of where, when and by whom the sample was taken.

The verification team understands that sample preparation by CEFAS at the Whitehaven out-station, on behalf of the FSA, is not accredited under ISO 17025. The Lowestoft laboratory is the location where the Sellafield and other UK samples are prepared for FSA, in accordance with the Cefas UKAS accreditation (ISO 17025).

Efforts are made to avoid taking under sized shellfish to protect the sustainability of the resource. Where no suitable sized shellfish can be found in an area traditionally sampled the focus will move to

another area nearby or in the worst case scenario may mean that that particular shellfish is not sampled at a given time.

At the CEFAS building on Whitehaven pier a NaI detector is available for emergency use but is not used on a routine basis.

Controlled copies of CEFAS operating procedures are held on a computerised system (known as TRIM). However, at the time of the visit CEFAS Whitehaven was not connected to this system and therefore the operator did not have access to a controlled copy of the sample preparation procedure. CEFAS Lowestoft informed the verification team that operations at Whitehaven are not included in a CEFAS accreditation; however accredited procedure WPD4A is partially applicable to preparation of winkle samples. CEFAS Lowestoft also informed the verification team that access to the TRIM system would be extended to the Whitehaven outstation in the near future.

The verification performed does not give rise to any suggestions or recommendations.,

6.3 HEALTH PROTECTION AGENCY

An air sampler operated by the Health Protection Agency, located on a farm inland from Seascale was visited. The polycarbonate filter is changed fortnightly and the total volume sampled in that period is of the order of 45-48000 m3. The filter is sent to the Health Protection Agency's Chilton laboratory for gamma and actinide analysis. The HPA operates further such air sampling stations in Glasgow, the Channel Islands, and at HPA HQ in Chilton. Currently, the results generated are not transmitted to the Environment Agency, although both agencies are reflecting upon whether the results should be included in future RIFE reports.

The verification performed does not give rise to any suggestions or recommendations.

7 LILLYHALL VERY LOW LEVEL RADIOACTIVITY DISPOSAL FACILITY

7.1 INTRODUCTION

Lillyhall Landfill Site is an existing landfill site operated by Waste Recycling Ltd (WRL), which was formerly only Permitted to dispose of inert, non-hazardous and household wastes and asbestos/asbestos contaminated waste in a dedicated cell. On the 6th of April 2011 a Permit was issued to dispose of High Volume Very Low Level Waste (HV-VLLW), although at the time of the visit receipts had not yet commenced. HV-VLLW is radioactive waste with maximum concentrations of 4 MBq t-1, although for waste containing tritium (H-3) the concentration limit for tritium is 40 MBq t-1. Low Level Waste (LLW) is radioactive waste having a radioactive content not exceeding 4000 MBq t-1 of alpha activity or 12000 MBq t-1 of beta/gamma activity. The Low Level Waste Repository (LLWR) in Cumbria is the UK national facility for the disposal of LLW. At present, HV-VLLW arising during the operation or decommissioning of UK nuclear facilities is sent for disposal at the LLWR.

The proposed use of the site for the disposal of HV-VLLW is a joint venture between WRL and EnergySolutions (EU) Ltd.

Stages 1 and 2 of the site are complete and have been capped and restored. Disposals to Stage 3 began in 1998. This stage is divided into ten separate waste disposal cells, four of which have already been filled. The fifth is expected to be filled soon. During the period 1995 to 2004 a small number of disposals of radioactive waste were made to the Lillyhall Landfill Site under Exemption Orders relating to the UK Radioactive Substances Act 1993. These included "Naturally Occurring Radioactive Material" (NORM) waste streams produced by the oil and gas industry.

It estimated that the total remaining disposal volume at the site is 1.5 million cubic metres. The conditions within the disposal permit limit the total quantity of HV-VLLW disposed at the site to 582000 cubic metres, with an annual limit of 26000 cubic metres.

All of the cells which will be used for the disposal of HV-VLLW have been, or will be lined with a minimum of 1 metre of engineered clay, combined with 2 metres of in-situ clay. Liner design is

expected to evolve as the site progresses, and a proposed new composite liner will consist of a minimum of 1 metre of clay overlain by a 2 mm thick High Density Polyethylene (HDPE) textured geomembrane and a 300 mm gravel drainage blanket, with the geomembrane extending to a height 4 metres above the base up the side slopes. Higher up the slopes, the liner will comprise a 1 metre thick clay liner. A recent Hydrogeological Risk Assessment has demonstrated that the proposed modifications to the design are sufficient for the controlled release of radioactivity in the HV-VLLW to groundwaters.

It is expected that the HV-VLLW will arrive at the Lillyhall Landfill Site in skips or tipper trucks. The waste will be covered during transport to prevent the re-suspension of dust and water ingress. Plastic liners or super sacks may be used to reduce any contamination of the transport container. The HV-VLLW will be loose-tipped to one side of the cell and non-radioactive waste will be disposed to other parts of the cell. HV VLLW is proposed to be deposited in its own dedicated cell and once complete this area will be engineered in the same manner as the dedicated asbestos cell, after which it will be covered with non-hazardous waste. There will be no intimate mixing between the radioactive and non-radioactive wastes. The waste will be tipped in such a way as to ensure that large gradients in slope do not arise, there is no slumping of the waste and the addition of a soil layer on top of the HV-VLLW is practicable.

It is planned that, after each disposal operation, the radioactive waste will be covered with a layer of soil. The thickness of the soil will be sufficient to ensure that particulate material in the waste cannot be blown away by the wind. It has been estimated that 3% to 20% of soil will be added.

It is not intended to store waste at the site, the Permit requires that the delay before disposal of the waste be no more than 8 hours. There will be no buffer stores.

There is no intention to retrieve the waste after disposal. During operation of the waste cell, there would be no difficulty in retrieving the waste since it will have been loose-tipped and covered only with soil. Retrieval of waste from a capped waste cell would require the removal of layers of non-hazardous waste,and capping materials, mainly top soil and restoration soils.

When each cell has been filled, it will be capped. Although the design of future cells will be reviewed before construction and will be subject to approval, the most recent cell to be capped has a cap which includes the following elements:

construction of a top soil layer at least 0.3 m thick;

installation of 1mm Linear Low Density Polyethylene (LLDPE) Geomembrane;

installation of Gas Well Boot details;

installation of Geotextile Protection Layer;

placement of restoration Soils at least one metre thick.

The LLDPE Geomembrane is “double rough” to minimize the subsequent movement of soil.

It is expected that the site will remain in operation, accepting waste for disposal, until 2031. At the end of this “operational period”, there will be a sixty year period of institutional control, during which the site will continue to be managed and monitored. All of the waste cells will have been capped and the integrity of the caps will be maintained throughout this period, as will the active control measures for landfill gas and the leachate management arrangements. During this period the site will continue to be subject to regulation by the Environment Agency.

This plan is for the disposal at the Lillyhall site of nuclear industry HV-LLLW. Given the location of the site approximately 21 km from Sellafield and Calder Hall, 30 km from the LLWR near Drigg and 50 km from the decommissioning Magnox power station at Chapelcross, it is well placed to receive consignments of HV-LLW from these nuclear sites. Potential candidate waste streams include certain decommissioning waste streams from Chapelcross, HV-VLLW which is currently consigned to the LLWR from Sellafield, future decommissioning waste streams from Sellafield and Calder Hall and any waste which might be consigned from the LLWR, with LLWR being the initial recipient of the waste and then acting as consignor for subsequent disposal at the Lillyhall Landfill Site. In addition,

the site may be used in the interim for the disposal of wastes from other nuclear sites pending the development and availability of alternative HV-VLLW disposal sites in those locations.

The future disposal inventory is not known in detail because waste streams for disposal will only be identified as a result of commercial agreements.

7.2 ENVIRONMENTAL MONITORING

The Lillyhall Landfill Site operates a continuous improvement regime and is accredited to ISO 14001. The site operates to an Integrated Management System Manual developed to achieve coordinated and integrated implementation of the company's Environmental, Health and Safety, and Quality Policies, and including supporting procedures and documents. Management reviews are carried out following a defined agenda and at a regular frequency to ensure that the Integrated Management System remains effective and is continually improved. A documented procedure is operated to ensure that any non-conformances, issues and concerns are recorded and managed. They may be raised by anyone within the business. The Integrated Management System is intended to ensure compliance with the regulations and operator's local rules. The Permit places conditions on the acceptance of waste for disposal and includes requirements placed on the operator to ensure compliance. The operator is required to visually inspect the radioactive waste to satisfy himself as far as reasonably practicable that it conforms to the consignor's characterization document provided for that radioactive waste. Radioactive waste found not to meet the conditions of the Permit is to be returned to the consignor. The operator is required to use Best Practicable Means when taking samples and conducting measurements, tests, surveys, analyses and calculations, to determine compliance with the limitations and conditions of the Permit Any samples taken have to be retained for at least one month and the results of any analysis for at least two years. The Permit also includes a list of requirements for sampling and monitoring in and around the site.

While the facility is operational, the cell into which waste is being disposed will remain uncapped although daily cover will be applied, allowing rainwater to infiltrate into the waste material and allowing some of the radioactivity to be leached into that water. There may also be some rainwater infiltration into cells which have been capped. While the facility is operational, most of the leachate will be collected and, after appropriate biological treatment, discharged to the sewer and treated at the sewage works. Any solids arising from the on-site pre-treatment of liquid effluent will be retained for disposal at the site. Sludge from the sewage works is used to improve agricultural land and the treated sewage effluent is discharged directly to the Irish Sea.

The dominant source of radioactivity in effluent from the site will be from leachate management.
The Permit includes a programme of sampling and monitoring which the operator is required to undertake. The programme includes:

- annual spot samples of groundwater from two boreholes upstream of the disposal site;
- quarterly spot samples of groundwater from two boreholes downstream of the site;
- annual spot sample from the main combined flow of leachate into the pre-treatment plant;
- annual composite sample of treatment plant sludge representative of the bulk sludge;
- quarterly 24-hour flow proportional sample from the treatment plant final discharge point to the sewer;
- bi-annual spot sample of surface water within the site from the lagoon which receives water from the vehicle wheel wash facility;
- bi-annual spot sample of surface water from Distington Beck downstream of the site.

Each of these samples is to be analysed for total alpha and beta and for tritium, and to undergo gamma spectrometric analysis. The results are to be reported to the Agency, including all of the radionuclides which have detected by gamma spectrometry.

Control and trigger levels have been incorporated within the non-radiological groundwater monitoring regime at the site to provide early warning and allow management intervention if found to be necessary. Although the release of radioactivity in liquid effluent from the site is limited by the conditions placed on the radionuclide inventory in the waste which is received for disposal, suitable trigger levels and an action plan to be implemented in the event of contamination arising from the site will be clearly set out.

Monitoring in the event that an action level has been exceeded can be considered to serve three purposes:

- assess the maximum and most likely radiological dose exposures to the most exposed person to determine whether further action is required to ensure protection of the local population.
- determine whether a longer term release term or environmental pathway exists which may require remedial action at source.
- identify whether the initial analysis is representative of the sample or prevailing conditions.

The generic action plan in the event that an action level is exceeded is to instigate repeat sampling, sampling of other materials which may be impacted, and to undertake more detailed analysis (e.g. for a range of radionuclides).

Although, specific action levels have not been proposed in the permit application, it is likely that action levels will initially be set at a level 3 to 10 times the anticipated concentration in groundwater or air.

7.3 VERIFICATIONS

When the date for the verification exercise was agreed with the UK authorities, it was assumed that the facility would have received HV-VLLW by the time of the visit. This proved not to be the case, and therefore the team limited itself to examination of the declared intent in terms of discharge monitoring.

Following a presentation by the facility's operator, the team visited the disposal facility and the associated effluent treatment plant starting with the area of the site currently receiving waste, located beside the first cell intended for HV-VLLW. As noted previously, deliveries of HV-VLLW have not yet commenced, however the manner in which this waste will be treated is expected to be broadly similar to that for household/industrial waste and the team witnessed the compacting and subsequent covering of non-radioactive waste.

All waste cells are engineered in the same manner, to permit operational flexibility. Cells containing HV-VLLW would normally be topped with household refuse in order to ensure that the closed cell's level is correct in relation to its neighbours.

In addition to the landfill site visit the team also saw the methane collection station and the associated electricity generator, whose output is fed to the National Grid. Recovering methane requires the making of penetrations into waste cells,however, the waste streams containing HV-VLLW are not anticipated to contain significant quantities of biodegradable components and therefore gas collection is not envisaged in these cells.

Leachate from the pits is collected at a central point, from where samples will be taken. Current sampling only relates to non-radioactive hazards which the leachate may present. The leachate treatment plant uses a biological process to clean the leachate from the whole site. The resulting cleaned leachate passes to Workington sewage works for purification, whilst the process sludge is dried and disposed of at the landfill site.

Once the site starts receiving deliveries of HV-VLLW, it is planned that monitoring samples will be analysed at the nearby Babcock Environmental Laboratory (which was visited in the context of the off-site monitoring programme of Sellafield Ltd).

On the assumption that environmental monitoring at the facility will be carried out as described to the verification team, the visit does not give rise to suggestions or recommendations.

8 BABCOCK ENVIRONMENTAL LABORATORY

8.1 INTRODUCTION

Sellafield Ltd. has subcontracted nearly all of its off-site environmental measurements to the Babcock Environmental Laboratory The building housing the laboratories and offices has been on the site at Westlakes Science & Technology Park since 1991 and was formerly known as the Geoffrey Schofield Laboratory. The majority of procedures in place for analyses were adopted by Babcock when they took over the laboratory in July 2010.

Some 50 people are employed, mainly in the laboratories or in management posts. ISO 17025 accreditation is held for the vast majority of analytical methods. Any analyses which are seldom requested and not covered by an accreditation are carried out to standards, of an equivalent level to ISO 17025. The laboratory sub-contracts out the analysis of ^{14}C and ^{3}H in food-stuffs.

Sellafield Ltd carried out annual audits of the work performed for them by Babcock. Each annual audit focusses on a specific theme.

Samples may be handled up to a radioactivity level equivalent to that of very low level waste.. Nevertheless such samples are rarely handled, the vast majority of samples analysed merely confirm the absence of contamination or are at the detection limit of the equipment. The laboratory includes a separated area for handling soil samples and the like, which may contain levels of radioactivity which are an order of magnitude higher.

Apart from the Krypton sample bags, all samples analysed by Babcock on behalf of Sellafield Ltd are collected and delivered by Sellafield Ltd's sampling team. Sample taking is managed by Sellafield Ltd's Eagle database which is designed to implement the sampling programme specified in the Environment Agency's Compilation of Environment Agency Requirements (CEAR) document.

All samples arriving at the laboratory are accompanied by a change of custody form. Additionally the sample is examined on arrival and any sample which presents anomalies will be returned to the customer.

At the time of the visit, Babcock were close to completing the implementation of an in-house Laboratory Information Management system (LIMS). At the time of the visit only borehole water analyses results were being input, but it was expected that the system would be in full operation by October 2011.

The laboratory has partial access to the centralised results database of Sellafield Ltd, SLIMS (Sellafield Laboratory Information Management System) where they can record the results of the analyses carried out. Babcock retains paper records for about 18 months. The requirements on archiving are set out in the CEAR and Sellafield Ltd are responsible for archiving.

8.2 VERIFICATIONS

Currently in the event of a temporary loss of electrical power to the laboratory there is no uninterruptable power supply in place owing to the high energy requirements of the instruments. Should power be lost for a longer period of time there are contingency plans to hire diesel generators. At present any loss of power would have a limited impact on sample throughput as reporting is well within statutory deadlines.

The verification team followed the "paper trail" generated by a sample from the Seascale HVAS to examine sample and result management at Babcock. Procedures, calibration charts and personnel training records were also checked for analyses, personnel and equipment involved in the analysis of the sample. No problems were found.

The team also verified document control at the laboratory more generally. In all labs visited the various manuals relating to the operation of the equipment and procedures for carrying out analyses were accessible. Some procedures showed signs of manual corrections which would subsequently be incorporated in a future version of the procedure. Training logs for all staff working in the labs were also readily available. For each change of procedure the operators which have been trained for that particular procedure sign their training record to acknowledge that they have been updated on the procedure.

A total of 13 HPGe are available, each was clearly labelled with the efficiency, the geometries supported and the radionuclides which could be analysed. An additional coloured label indicated if the instrument was operating normally, whether maintenance was required or whether the instrument was out of use. Each is filled with liquid nitrogen twice per week. A mixed Co60 /Cs 137 source is used for daily QC measurements and a monthly background measurement is carried out. The team checked the records of these QC measurements. Full instrument calibrations are carried out when detectors return from repair or when new detectors are installed. Otherwise, the calibration is checked every two years. The measurement stations run VMS and the NWA Quality Package is used. Optical disks are used for archiving of measurements.

The team also witnessed the preparatory chemical separation of Americium from a sample. The method used was developed in-house and the team was provided with the in-house method validation report. Subsequently, the separated Am would be electro-deposited on a planchet. The method yield is followed using isotopic tracers and the laboratory is currently developing an improved tracer method.

The team visited the mass-spectrometry laboratory, where uranium in HVAS samples is determined using a Perkin Elmer Elan DRC ii ICP/MS. Although accreditation had been received for the analysis of water, at the time of the visit accreditation had not yet been granted for the analysis of uranium-HVAS samples. Internally, the laboratory runs comparisons with the alpha spectrometric method. The laboratory has also recently participated in a recent NUSIMEP inter-comparison organised by the European Commission and is currently participating in an international inter-comparison exercise organised by the Commissariat à l'énergie atomique.

The verification team were given a very instructive presentation of the method used for the analysis of ^{85}Kr from the air samples collected at Sellafield Metrological Station. In common with all other methods used the team received copies of the relevant laboratory manuals for scrutiny. These were found to be very clearly written.

One member of the verification team was also given a rapid tour of the whole laboratory, including equipment not used for Sellafield samples. The overall impression was very positive.

The verifications performed do not give rise to any suggestions.

9 CONCLUSIONS

All verification activities that had been planned were completed successfully. In this regard, the information supplied in advance of the visit, as well as the additional documentation received during and after the verification activities, was useful.

The information provided and the verification findings led to the following observations:

(1) The verification showed that – for the facilities visited – the recommendations laid down at the verification in 2004 have been taken up or good reasons for not implementing them have been given. Thus, the recommendations are no longer pertinent.

(2) The verification activities that were performed demonstrated that the facilities necessary to carry out continuous monitoring of levels of radioactivity in the air, water and soil at the site of

Sellafield are adequate. The Commission could verify the operation and efficacy of these facilities.

(3) With regard to the Lillyhall very low level radioactive waste repository the planned environmental monitoring programme, as presented to the verification team, appears adequate.

(4) The Commission Services ask the UK competent authority to inform them of any achievements since the time of the verification.

(5) The verification team acknowledges the excellent co-operation it received from all persons involved in the activities it performed.

APPENDIX 1

REFERENCES & DOCUMENTATION

EA (Environment Agency) and FSA (Food Standards Agency)

- Radioactivity in Food and the Environment, annual RIFE reports – issued by EA + FSA + SEPA +NIEA

These reports are also available on the Environment Agency and Food Standards Agency websites: www.environment-agency.gov.uk and www.food.gov.uk

- Report, Environment Agency (EA) & Food Standards Agency (FSA) monitoring programmes, July 2010 together with amendments to reflect the situation in August 2011.
- Radiological Monitoring Technical Guidance Note 2 – Environmental Radiological Monitoring. Report produced by EA, FSA and Scottish Environment Protection Agency, December 2011.

Waste Recycling Group (Lillyhall

- General data relating to the arrangements for the disposal of radioactive wastes as called for under Article 37 of the Euratom treaty
- Permit CD7914 under the Environmental Permitting (England & Wales) Regulations 2010.
- Lillyhall Sampling & Monitoring Plan in respect of Permit CD7914.
- Lillyhall Environmental Monitoring Protocols.
- Lillyhall Baseline Monitoring Data

Sellafield Limited

- Permit with introductory note number KP3690SX

Babcock Ltd.

- Laboratory manuals for all Sellafield Ltd. analyses performed

European Commission- Radiation Protection Unit

- Technical Report UK 04/1 and associated Main Findings document

APPENDIX 2

THE VERIFICATION PROGRAMME

Tuesday 23 August 2011

Timing	Session	Location	Attendees
10:00	Tea/coffee on arrival	Environment Agency office, Penrith	-
10:30	Welcome and introductions (Ian Parker, Environment Agency and Phil Edge NDA) Presentations and questions: • EC team – Scope and purpose of visit • Sellafield Ltd – Environmental monitoring programmes around Sellafield • WRL Lillyhall – Environmental monitoring at Lillyhall landfill site • Environment Agency / Food Standards Agency – Independent food and environment monitoring programmes • Health & safety brief for visit		EC team (Alan Ryan, Finlay Maclean) P Edge (NDA) I Parker (EA) R Allott (EA) S Tandy (EA) D Batey (EA) S Runacres (FSA) SL reps Brian McMeekin (WRL)
13:00	Leave for Lillyhall landfill site	EC team to travel in own vehicle	
14:00	Welcome at Lillyhalll landfill site (including H&S brief)	WRL Lillyhall landfill site	EC team D Batey (EA) Brian McMeekin (WRL) + Site Manager
14:15	Inspection of environmental monitoring		

Wednesday 24 August 2011

Timing	Session	Location	Attendees
09:00	Meet at Sellafield Centre. Health & Safety brief.	Sellafield Centre	EC team Jim Desmond (SL) R Allott (EA) S Runacres (FSA) Derek Hammond (HPA)
09:15	Inspection of air monitoring arrangements at meteorological mast (Kr-85)	Meteorological mast near Sellafield site	
10:15	Inspection of high-volume air sampling, view rainwater sampling equipment. River water sampling at Calderbridge	Calderbridge	
11:15	Inspection of Health Protection Agency air monitoring at Seascale	Seascale	
13:45	Introduction to independent monitoring field teams (including H&S brief)	Nethertown	EC team Jim Desmond (SL) R Allott (EA) S Runacres (FSA) EA Contractor reps Roger Benzing (ESG) Rose Rodwell (ESG) Cefas Reps
14:00	Demonstration of winkle/sediment collection and dose rate monitoring		
15:30	Welcome and introduction to at Cefas laboratory (including H&S brief)	Cefas laboratory, Whitehaven	
15:45	Inspection of winkle preparation		

Thursday 25 August 2011

Timing	Session	Location	Attendees
09:00	EC team meet at Babcock Environmental Laboratory (Sellafield Ltd contract laboratory)	-	
09:00	Welcome and introduction to laboratory (and H&S brief)	Babcock Environmental Laboratory, Westlakes Science & Technology Park	EC team Jim Desmond (SL) S Tandy (EA) S Runacres (FSA)
09:30	Inspection of analysis of environmental samples		
12:00	EC team travel to Environment Agency offices, Penrith	-	-
14:30	Closing meeting and questions		EC team P Edge (NDA) I Parker (EA) R Allott (EA) S Runacres (FSA) SL reps WRL reps

APPENDIX 3

Environment Agency Monitoring in Sellafield Area

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Natural Waters			
Ehen Spit beach groundwater springs	NY 019 033	4 (Quarterly)	Cl^-, Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{90}Sr, ^{238}Pu, $^{239,240}Pu$, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
River Ehen 100m downstream of factory sewer outfall	NY 024 028	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{90}Sr, ^{238}Pu, $^{239,240}Pu$, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
River Calder downstream of site	NY 025 027	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{90}Sr, ^{238}Pu, $^{239,240}Pu$, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
River Calder upstream of site	NY 035 045	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{90}Sr, ^{238}Pu, $^{239,240}Pu$, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Drigg stream	SD 062 984	4 (Quarterley)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{90}Sr, ^{210}Po, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239,240}Pu$, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
British Rail Drain	NY 056 995	1	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{90}Sr, ^{210}Po, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239,240}Pu$, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Reservoir Supplies			
Wast Water	NY 150 051	1	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{40}K, ^{60}Co, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Ennerdale Water	NY 089 156	1	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{40}K, ^{60}Co, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Devoke Water	SD 163 972	1	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{40}K, ^{60}Co, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Thirlmere	NY 307 183	1	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{3}H, ^{40}K, ^{60}Co, ^{137}Cs and other gamma emitting nuclides present above the detection limit.

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Sediment			
West Cumbria			
Maryport Outer Harbour	NY 032 367	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Workington Harbour	NX 988 293	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Harrington Harbour	NX 988 253	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Whitehaven Outer Harbour:	NX 968 185	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
St Bees beach	NX 959 116	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Sellafield beach south of former pipeline	NY 018 032	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
River Calder: Upstream of site Downstream of site	 NY 035 045 NY 025 027	 2 2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Seascale beach	NY 036 008	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Carleton Marsh	SD 064 983	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
River Mite Estuary	SD 092 976	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Raven Villa	SD 085 967	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Newbiggen/Eskmeals (Bridge)	SD 090 941	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{90}Sr, ^{238}Pu, $^{239,240}Pu$, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Haverigg	SD 164 784	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Millom	SD 187 800	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Low Shaw	SD 197 844	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Walney Channel: South of Vickers discharge point	SD 195 678	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Walney Channel: North of Vickers discharge point	SD 187 689	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Drigg Stream	SD 062 984	4 (Quarterley)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs), ^{90}Sr, ^{210}Po, ^{228}Th, ^{230}Th, ^{232}Th, ^{234}U, ^{235}U, ^{238}U, ^{238}Pu, $^{239,240}Pu$, ^{241}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
North and South Cumbria			
Newton Arlosh	NY 200 565	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Sand Gate Marsh	SD 353 762	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Flookburgh or Kent's Bank (depending on accessibility)	SD 365 735 or SD 397 755	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Lancashire, Merseyside, North Wales and Isle of Man			
Sunderland Point	SD 427 562	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Conder Green	SD 456 561	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Hambleton	SD 367 428	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Fleetwood shore	SD 333 485	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Skippool Creek	SD 356 408	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Blackpool	SD 304 339	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Crossen Marsh Track	SD 343 206	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Ainsdale	SD 296 132	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
New Brighton	SJ 301 945	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Rock Ferry	SJ 336 868	4 (Quarterly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Rhyl	SH 995 805	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Llandudno	SH 804 823	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Caerhun	SH 779 704	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Llanfairfechan	SH 666 743	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Isle of Man: Ramsey	SC 453 946	1	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{125}Sb, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{154}Eu, ^{155}Eu and other gamma emitting nuclides present above the detection limit.
Seawater			
Seascale	NY 036 008	2	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{90}Sr, ^{99}Tc, ^{40}K, ^{60}Co, ^{106}Ru, ^{110m}Ag, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
St Bees	NX 959 116	2 Limited analysis* 12 (monthly)	Total alpha (as ^{236}Pu), Total beta (as ^{137}Cs) ^{3}H*, ^{90}Sr, ^{99}Tc*, ^{40}K, ^{60}Co, ^{106}Ru, ^{110m}Ag, ^{134}Cs*, ^{137}Cs*, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Seaweed			
Vicinity of former Sellafield pipeline	NY 018 033	2	^{90}Sr, ^{99}Tc, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
St. Bees (West)	NX 958 117	2	^{90}Sr, ^{99}Tc, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Harrington Harbour	NX 988 253	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Ford at Ravenglass	SD 084 966	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Silloth Harbour	NY 105 535	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Portmadoc	SH 570 382	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Fishguard	SM961 375	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Isle of Man: Port Lewaigue (Ramsey Bay)	SC 467 931	4	^{99}Tc, ^{234}U, ^{235}U, ^{238}U, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Seaweed (to monitor further field impact of Sellafield ^{99}Tc discharges)			
Bradwell: Waterside	TL 994 080	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Dungeness: Folkestone Harbour	TR 232 360	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Hinkley Point: Near pipeline	ST 215 465	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Oldbury and Berkeley: Near pipeline	ST 653 992	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Heysham: Half Moon Bay	SD 404 607	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Hartlepool: Pilot Station	NZ 555 276	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Wylfa: Cemaes Bay	SH 374 936	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Bognor Rock	SZ 922 983	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Lavernock Point	ST 189 679	2	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Isles of Scilly	SW 907 108	1	^{99}Tc, ^{40}K, ^{60}Co, ^{95}Nb, ^{95}Zr, ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{131}I, ^{134}Cs, ^{137}Cs, ^{144}Ce, ^{241}Am and other gamma emitting nuclides present above the detection limit.
Drainage Gully Pots			
Seascale GJH SS 204	NY 038 006	1	^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Seascale GJH SS 233	NY 039 006	1	^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Seascale GJH SS 209	NY 037 007	1	^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Seascale GJH SS 232	NY 037 008	1	^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Seascale GJH SS 231	NY 036 009	1	^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Whitehaven GJH SS 201	NX 974 183	1	^{90}Sr, ^{238}Pu, ^{239,240}Pu, ^{241}Am, ^{40}K, ^{60}Co, ^{134}Cs, ^{137}Cs and other gamma emitting nuclides present above the detection limit.
Instrumental Monitoring			
West Cumbria			
Maryport Outer Harbour	NY 032 367	2	Gamma dose rate at 1 m height
Workington Harbour	NX 988 293	2	Gamma dose rate at 1 m height
Harrington Harbour	NX 988 253	2	Gamma dose rate at 1 m height
Whitehaven Outer Harbour:	NX 968 185	4 (Quarterly)	Gamma dose rate at 1 m height Beta dose rate at surface
St Bees beach	NX 959 116	4 (Quarterly)	Gamma dose rate at 1 m height Beta dose rate at surface
Nethertown beach	NX 989 072	2	Gamma dose rate at 1 m height
Braystones beach	NY 000 060	2	Gamma dose rate at 1 m height
Sellafield beach north of former pipeline	NY 018 033	2	Gamma dose rate at 1 m height Beta dose rate at surface
Sellafield Dunes	NY 019 035	2	Gamma dose rate at 1 m height
Sellafield Beach south of former pipeline	NY 018 032	2	Gamma dose rate at 1 m height
River Calder: Upstream of site Downstream of site	 NY 035 045 NY 025 027	 2 2	Gamma dose rate at 1 m height
Seascale beach	NY 036 008	4 (Quarterly)	Gamma dose rate at 1 m height
Seascale grass/car park	NY 037 010	4 (Quarterly)	Gamma dose rate at 1 m height
Muncaster Bridge	SD 112 964	4 (Quarterly)	Gamma dose rate at 1 m height
Carleton Marsh	SD 064 983	4 (Quarterly)	Gamma dose rate at 1 m height
Salmon Garth	SD 087 957	4 (Quarterly)	Gamma dose rate at 1 m height
Boat area	SD 084 962	4 (Quarterly)	Gamma dose rate at 1 m height
Ford	SD 083 966	4 (Quarterly)	Gamma dose rate at 1 m height
River Mite Estuary	SD 092 976	4 (Quarterly)	Gamma dose rate at 1 m height
Raven Villa	SD 085 967	4 (Quarterly	Gamma dose rate at 1 m height Beta dose rate at surface

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Newbiggen/Eskmeals (Viaduct)	SD 088 942	4 (Quarterly)	Gamma dose rate at 1 m height
Newbiggen/Eskmeals (Bridge)	SD 090 941	4 (Quarterly)	Gamma dose rate at 1 m height
Eskmeals Nature Reserve	SD 084 944	4 (Quarterly)	Gamma dose rate at 1 m height
Tarn Bay	SD 079 906	2	Gamma dose rate at 1 m height
Silecroft	SD 121 810	2	Gamma dose rate at 1 m height
Haverigg	SD 164 784	2	Gamma dose rate at 1 m height
Millom	SD 187 800	2	Gamma dose rate at 1 m height
Low Shaw	SD 197 844	2	Gamma dose rate at 1 m height
Tumner Hill Marsh	SD 182 678	2	Gamma dose rate at 1 m height
Askam	SD 208 782	2	Gamma dose rate at 1 m height
Walney Channel: South of Vickers discharge point	SD 195 678	2	Gamma dose rate at 1 m height
Walney Channel: North of Vickers discharge point	SD 187 689	2	Gamma dose rate at 1 m height
Roa Island	SD 233 651	2	Gamma dose rate at 1 m height
St Bees beach	Varies according to survey	4 (Quarterly)	Beta/gamma contact contamination
Seascale beach		4 (Quarterly)	Beta/gamma contact contamination
Drigg beach		4 (Quarterly)	Beta/gamma contact contamination
Saltcoats beach		4 (Quarterly)	Beta/gamma contact contamination
Both banks of River Ehen from confluence to Sellafield Station		4 (Quarterly)	Beta/gamma contact contamination
Both banks of River Calder within 200 m of Ehen confluence		4 (Quarterly)	Beta/gamma contact contamination
Ravenglass (from Raven Villa to Mountain View)		4 (Quarterly)	Beta/gamma contact contamination
Beaches between St Bees and Drigg Point		2	Beta/gamma contact contamination
Both banks of River Ehen from Sellafield station to tidal limit		2	Beta/gamma contact contamination
Ravenglass Estuary coastline		1	Beta/gamma contact contamination
Windblown debris in popular recreation areas: Promenade & Play area St Bees Grass banks and bungalows at: Coulderton Nethertown Braystones Dunes and grass banks at Sellafield Grass banks and car park at Seascale Grassed areas and car park at Ravenglass Roadway at Newbiggin subject to flooding		1 at each location	Beta/gamma contact contamination
Silloth Beach		Once per 3 years	Beta/gamma contact contamination
Allonby Beach		Once per 3 years	Beta/gamma contact contamination
Maryport Beach		Once per 3 years	Beta/gamma contact contamination

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Siddick Beach	Varies according to survey	Once per 3 years	Beta/gamma contact contamination
Harrington harbour and beach		Once per 3 years	Beta/gamma contact contamination
Parton beach		Once per 3 years	Beta/gamma contact contamination
Whitehaven north and south beaches		Once per 3 years	Beta/gamma contact contamination
Gutterby beach		Once per 3 years	Beta/gamma contact contamination
Silecroft beach		Once per 3 years	Beta/gamma contact contamination
Low Shaw		Once per 3 years	Beta/gamma contact contamination
Walney beach		Once per 3 years	Beta/gamma contact contamination
North and South Cumbria			
Rockcliffe Marsh	NY 335 640	2	Gamma dose rate at 1 m height
Burgh Marsh	NY 295 595	2	Gamma dose rate at 1 m height
Port Carlisle 1	NY 241 622	4 (Quarterly)	Gamma dose rate at 1 m height
Port Carlisle 2	NY 239 624	4 (Quarterly)	Gamma dose rate at 1 m height
Greenend 1	NY 220 627	4 (Quarterly)	Gamma dose rate at 1 m height
Greenend 2	NY 219 627	4 (Quarterly)	Gamma dose rate at 1 m height
Cardurnock Marsh	NY 169 588	4 (Quarterly)	Gamma dose rate at 1 m height
Newton Arlosh	NY 200 565	4 (Quarterly)	Gamma dose rate at 1 m height
Silloth Harbour	NY 105 535	4 (Quarterly)	Gamma dose rate at 1 m height
Silloth Silt Pond	NY 104 533	4 (Quarterly)	Gamma dose rate at 1 m height
Allonby	NY 078 428	4 (Quarterly)	Gamma dose rate at 1 m height
Greenodd salt marsh	SD 316 826	2	Gamma dose rate at 1 m height
Sand Gate Marsh	SD 353 762	4 (Quarterly)	Gamma dose rate at 1 m height
Flookburgh or Kent's Bank (depending on accessibility)	SD 365 735 or SD 397 755	4 (Quarterly)	Gamma dose rate at 1 m height
High Foulshaw	SD 471 834	4 (Quarterly)	Gamma dose rate at 1 m height
Arnside 1	SD 455 787	4 (Quarterly)	Gamma dose rate at 1 m height
Arnside 2	SD 468 792	4 (Quarterly)	Gamma dose rate at 1 m height
Lancashire, Merseyside, North Wales and Isle of Man			
Sunderland Point	SD 427 562	4 (Quarterly)	Gamma dose rate at 1 m height
Sunderland	SD 428 568	4 (Quarterly)	Gamma dose rate at 1 m height
Colloway Marsh	SD 448 583	4 (Quarterly)	Gamma dose rate at 1 m height
Lancaster	SD 475 622	4 (Quarterly)	Gamma dose rate at 1 m height
Aldcliffe Marsh	SD 458 601	4 (Quarterly)	Gamma dose rate at 1 m height
Conder Green	SD 456 561	4 (Quarterly)	Gamma dose rate at 1 m height
Pilling Marsh	SD 416 497	4 (Quarterly)	Gamma dose rate at 1 m height
Heads - River Wyre	SD 352 455	4 (Quarterly)	Gamma dose rate at 1 m height
Height o' Hill Wyre	SD 355 448	4 (Quarterly)	Gamma dose rate at 1 m height
Hambleton	SD 367 428	4 (Quarterly)	Gamma dose rate at 1 m height
Fleetwood shore 1	SD 333 485	4 (Quarterly)	Gamma dose rate at 1 m height
Fleetwood shore 2 or Fleetwood Marsh nature Park (depending on accessibility)	SD 339 472 or SD 338 465	4 (Quarterly)	Gamma dose rate at 1 m height
Skippool Creek Bivand	SD 356 408 SD 358 413	4 (Quarterly) over mud and where access possible in boat cabins.	Gamma dose rate at 1 m height
Blackpool	SD 304 339	4 (Quarterly)	Gamma dose rate at 1 m height
Crossen Marsh track	SD 343 206	4 (Quarterly)	Gamma dose rate at 1 m height
Ainsdale	SD 296 132	4 (Quarterly)	Gamma dose rate at 1 m height
New Brighton	SJ 301 945	4 (Quarterly)	Gamma dose rate at 1 m height
West Kirby	SJ 215 859	4 (Quarterly)	Gamma dose rate at 1 m height
Rock Ferry	SJ 336 868	4 (Quarterly)	Gamma dose rate at 1 m height
Little Neston Marsh 1	SJ 287 763	2	Gamma dose rate at 1 m height
Little Neston Marsh 2	SJ 288 765	2	Gamma dose rate at 1 m height

Location	**OS Grid Reference**	**Sampling Frequency (y^{-1})**	Analytical Requirement
Flint 1 (Mud)	SJ 248 733	2	Gamma dose rate at 1 m height
Flint 2 (Salt Marsh)	SJ 248 733	2	Gamma dose rate at 1 m height
Prestatyn	SJ 058 838	2	Gamma dose rate at 1 m height
Rhyl	SH 995 805	2	Gamma dose rate at 1 m height
Llandudno	SH 804 823	2	Gamma dose rate at 1 m height
Caerhun	SH 779 704	2	Gamma dose rate at 1 m height
Llanfairfechan	SH 666 743	2	Gamma dose rate at 1 m height
Isle of Man: Ramsey	SC 343 486	1	Gamma dose rate at 1 m height
Knott End	SD343 486	2	Gamma dose rate at 1 m height
Monitoring of Fishing Gear			
Drigg – Selker - Dose over gill nets		4	Contact beta dose rate
Drigg – Selker - Dose over lobster pots		4	Contact beta dose rate
Ravenglass - Dose over gill nets		2	Contact beta dose rate
Ravenglass - Dose over lobster pots		2	Contact beta dose rate
Sellafield pipeline - Dose over lobster pots		4	Contact beta dose rate
Sellalfield pipeline - Dose over nets		4	Contact beta dose rate
St Bees – west - Dose over net		4	Contact beta dose rate
St Bees – west - Dose over lobster pots		4	Contact beta dose rate
Fishing Vessel M - Dose over nets		4	Contact beta dose rate
Fishing Vessel M - Dose over ropes		4	Contact beta dose rate
Fishing Vessel Z - Dose over nets		4	Contact beta dose rate

APPENDIX 4

Scope of the Sellafield Sampling Undertaken by the Food Standards Agency (2009)

Measurement	Routine frequency of measurement	Analyses or measurements	Types of material	De tar
Aquatic programme				
Analysis of foods	Annually to monthly	Total beta, gamma spectrometry, ^{3}H, organic ^{3}H, ^{14}C, ^{90}Sr, ^{99}Tc, ^{147}Pm, $^{134/137}Cs$, Th, U, transuranics	Fish, crustaceans, molluscs, edible aquatic plants	Pla dog her tro sal lob coc dul sar
Terrestrial programme				
Analysis of foods	Annually to weekly[1]	Gamma spectrometry , ^{3}H, organic ^{3}H, ^{14}C, ^{90}Sr, ^{99}Tc, ^{129}I, ^{131}I, Cs, transuranics	Milk, crops and animals	Co live wo bla car eld mu ras str
Analysis of indicator	Annually	Gamma spectrometry, ^{99}Tc, ^{106}Ru, ^{144}Ce, U	Grass, soil	Gra

[1] For milk samples only – generally analysed as monthly bulks, but weekly sub-samples kept to allow for further investigation if required.

[2] Some of these sample types are taken as substitutes for those on the targeted programme.

[3] One sample location has weekly collection and analysis used to monitor for unusual discharges

APPENDIX 5

Food Standards Agency Aquatic Monitoring around Sellafield and farther afield for 2009

Location	Sample Type	Sampling Frequency	Analytical Requirement
Fish			
Sellafield coastal area	European sea bass	A	Gamma spec (L)
Sellafield coastal area	Grey mullet	A	Gamma spec (L)
Sellafield coastal area	European plaice	1st & 3rd samples rec'd	Pu/Am/Cm
Sellafield coastal area	European plaice	2&4 samples rec'd	H-3, OBT
Sellafield coastal area	European plaice	4 py	Total beta, gamma spec (L)
Sellafield coastal area	Round fish - white	1 & 3rd rec'd	Pu/Am/Cm
Sellafield coastal area	Round fish - white	4 py	Total beta, gamma spec (L)
Sellafield offshore area	Dab	2 py	Gamma spec (L)
Sellafield offshore area	Spurdog	2 py	Gamma spec (L)
Sellafield offshore area	European plaice	2 py	Gamma spec (L), I-129 (wet)
Sellafield offshore area	European plaice	1st sample rec'd	Pu/Am/Cm, Sr-90, Tc-99, Pm-147, C-14(N), C-14, Np-237
Sellafield offshore area	Round fish - white	2 py	Gamma spec
Sellafield offshore area	Round fish - white	1st sample rec'd	Pu/Am/Cm, Sr-90, Tc-99, C-14(N), C-14
Sellafield offshore area	Whiting	2 py	Gamma spec (L)
Maryport Commercial	European plaice	4 py	Gamma spec (L)
Whitehaven Area	European plaice	4 py	Gamma spec (L)
Whitehaven Area	European plaice	2nd sample rec'd	Pu/Am/Cm, Sr-90
Whitehaven Area	Round fish - white	A	C-14(N), C-14
Whitehaven Area	Round fish - white	4 py	Gamma spec (L)
Whitehaven Area	Round fish - white	2nd sample rec'd	Pu/Am/Cm, Sr-90
Whitehaven Area	Skates/rays	4 py	Gamma spec (L)
Whitehaven Area	Skates/rays	2nd sample rec'd	Pu/Am/Cm
Whitehaven Area	Sole (Dover sole)	4 py	Gamma spec (L)
Whitehaven Area	Sole (Dover sole)	2nd sample rec'd	Pu/Am/Cm
Off Whitehaven Harbour	Flat fish	A	Po-210
Parton (N)	Round fish - white	1st & 3rd samples rec'd	Po-210
Parton (N)	Round fish - white	4 py	Gamma spec (L)
Parton (N)	Round fish - white	2nd sample rec'd	U-r/n's, Pb-210, Th-r/n's
S Bees (W)	Round fish - white	1st & 3rd samples rec'd	Pu/Am/Cm
St Bees (W)	Round fish - white	4 py	Gamma spec (L)
Ravenglass	Round fish - white	2 py	Gamma spec (L)
Drigg - Selker	European plaice	1st & 3rd samples rec'd	Pu/Am/Cm
Drigg - Selker	European plaice	1st & 3rd samples rec'd	H-3, OBT
Drigg - Selker	European plaice	4 py	Gamma spec (L)
Drigg - Selker	Round fish - white	1st & 3rd samples rec'd	Pu/Am/Cm
Drigg - Selker	Round fish - white	4 py	Gamma spec (L)
Morecambe Bay (Flookburgh)	Flounder (European)	1st & 3rd samples rec'd	Pu/Am/Cm
Morecambe Bay (Flookburgh)	Flounder (European)	A	C-14, C-14(N)
Morecambe Bay (Flookburgh)	Flounder (European)	4 py	Gamma spec (L)
Morecambe Bay (Morecambe)	Flounder (European)	1st & 3rd sample bulked	Sr-90, Tc-99
Morecambe Bay (Sunderland Point)	Whitebait	A	Gamma spec (L), Sr-90, Pu/Am/Cm, Pu-241
River Calder	Brown trout	A	Gamma spec (L)

Location	Sample Type	Sampling Frequency	Analytical Requirement
River Calder	Sea Trout (brown trout)	A	Gamma spec (L)
Local fish farm 1	Rainbow trout	A	Gamma spec (L)
Local fish farm 2	Rainbow trout	2 py	Gamma spec (L)
Local fish farm 3	Rainbow trout	A	Gamma spec (L)
Local fish farm 4	Rainbow trout	A	Gamma spec (L), Pu/Am/Cm, C-14(N), C-14
Local fish farm 5	Rainbow trout	A	Gamma spec (L)
Devoke Water (Cumbria)	Brown trout	A	Gamma spec (L)
Devoke Water (Cumbria)	European perch	A	Gamma spec (L)
Ennerdale (Cumbria)	Brown trout	A	Gamma spec (L)
R Derwent	Sea trout (brown trout)	A	Gamma spec (L)
R Ehen	Sea trout (brown trout)	A	Gamma spec (L)
R Duddon	Sea trout (brown trout)	A	Gamma spec (L)
R Kent	Sea trout (brown trout)	A	Gamma spec (L)
R Esk	North Atlantic salmon	A	Gamma spec (L)
R Esk	Sea trout (brown trout)	A	Gamma spec (L)
Fleetwood	European plaice	4 py	Gamma spec (L)
Fleetwood	European plaice	1st sample rec'd	Pu/Am/Cm
Fleetwood	Round fish - white	1st & 3rd samples rec'd	Tc-99
Fleetwood	Round fish - white	A	C-14, C-14 (N)
Fleetwood	Round fish - white	4 py	Gamma spec (L)
Fleetwood	Round fish - white	1st sample rec'd	Pu/Am/Cm, Sr-90
Isle of Man	Herring	4 py	Gamma spec (L)
Isle of Man	Herring	1st sample rec'd	Pu/Am/Cm
Isle of Man	Round fish - white	4 py	Gamma spec (L)
Isle of Man	Round fish - white	1st sample rec'd	Pu/Am/Cm
Holyhead Irish Sea	Skates/Dogfish	4 py	Gamma spec (L)
Holyhead Irish Sea	Skates/Dogfish	1st sample rec'd	Pu/Am/Cm
Ribble Estuary	European sea bass	A	Gamma spec (L)
Ribble Estuary	Round fish - white	2 py	Gamma spec (L)
Ribble Estuary	North Atlantic salmon	A	Gamma spec (L)
Ribble Estuary	Sole (Dover Sole)	A	Gamma spec (L)
Ribble Estuary	Sea trout (brown trout)	A	Gamma spec (L)
NI farmed salmon	North Atlantic salmon	A	Gamma spec (L), Tc-99
Loch Dee (Dumfries and Galloway)	Brown trout	A	Gamma spec (L)
West of Scotland	European mackerel	A	Gamma spec (L)
West of Scotland	European mackerel	A	Gamma spec (L)
Scotland west coast farmed salmon	North Atlantic salmon	A	Gamma spec (L)
Peterhead Minch	Herring	A	Gamma spec (L)
Peterhead Minch	Herring	2 py	Bulk for Gamma spec (L)
Peterhead Minch	European mackerel	A	Gamma spec (L)

Location	Sample Type	Sampling Frequency	Analytical Requirement
Peterhead Minch	European mackerel	2 py	Bulk for Gamma spec (L)
Peterhead Minch	European mackerel	1st sample rec'd	Pu/Am/Cm, Sr-90, C-14(N), C-14
Shetland (Bressay)	Unspecified fish	2 py	Gamma spec (L)
Shetland (Bressay)	Unspecified fish	1st sample rec'd	Pu/Am/Cm, Sr-90
Shetland (Bressay)	Unspecified fish - Fish oil	2 py	Gamma spec (L)
Aberdeen north North Sea	Haddock	A	C-14(N), C-14
Aberdeen north North Sea	Haddock	2 py	Gamma spec (L)
Aberdeen north North Sea	Haddock	1st sample rec'd	Pu/Am/Cm
Aberdeen north North Sea	Herring	A	Gamma spec (L)
Aberdeen north North Sea	Herring	2 py	Bulk for Gamma spec (L)
Aberdeen north North Sea	European plaice	2 py	Gamma spec (L)
Aberdeen north North Sea	Round fish - white	2 py	Gamma spec (L)
Aberdeen north North Sea	Round fish - white	1st sample rec'd	Pu/Am/Cm, Sr-90
Hull Mid North Sea	European plaice	2 py	Gamma spec (L)
Hull Mid North Sea	European plaice	1st sample rec'd	Sr-90, C-14, C-14(N)
Hull Mid North Sea	Round fish - white	2 py	Gamma spec (L)
Hull Mid North Sea	Round fish - white	1st sample rec'd	Sr-90, C-14, C-14(N)
Lowestoft Southern North Sea	Flat fish	2 py	Gamma spec (L)
Lowestoft Southern North Sea	Flat fish	1st sample rec'd	Sr-90
Lowestoft Southern North Sea	Herring	A	Gamma spec (L)
Lowestoft Southern North Sea	Herring	2 py	Bulk for Gamma spec (L)
Lowestoft Southern North Sea	Round fish - white	2 py	Gamma spec (L)
Lowestoft Southern North Sea	Round fish - white	1st sample rec'd	Sr-90
English Channel - east	European plaice	2 py	Gamma spec (L)
English Channel - east	Round fish - white	2 py	Gamma spec (L)
English Channel - west	European plaice	2 py	Gamma spec (L)
English Channel - west	European plaice	1st sample rec'd	C-14, C-14(N)
English Channel - west	Whiting	2 py	Gamma spec (L)
English Channel - west	European mackerel	2 py	Gamma spec (L)
Local market shop	European plaice	2 py	Gamma spec (L)
Local market shop	Round fish - white	2 py	Gamma spec (L)
Skagerrak	Herring	2 py	Gamma spec (L)
Skagerrak	Round fish - white	2 py	Gamma spec (L)
Baltic Sea	Herring	2 py	Gamma spec (L)
Baltic Sea	Round fish - white	2 py	Gamma spec (L)
Barents sea	Round fish - white	2 py	Gamma spec (L)
Hull - Norwegian Sea	Herring	A	Gamma spec (L)
Hull - Norwegian Sea	Saithe	A	Gamma spec (L)
Hull - Norwegian Sea	Round fish - white	A	Gamma spec (L)
Hull - Norwegian Sea	European mackerel	A	Gamma spec (L)

Location	Sample Type	Sampling Frequency	Analytical Requirement
Hull Iceland	Round fish - white	A	Gamma spec (L)
Hull Iceland	Round fish - white	2 py	Bulk for Gamma spec (L)
Celtic Sea	Round fish - white	2 py	Gamma spec (L)
Celtic Sea	Round fish - white	1st sample rec'd	Sr-90, C-14, C-14(N)
Celtic Sea	Unspecified fish	2 py	Gamma spec (L)
Norwegian processed	Round fish - white	A	Gamma spec (L)
Norwegian processed	Round fish - white	2 py	Bulk for Gamma spec (L)
Norwegian processed	Round fish - white	1st sample rec'd	Pu/Am/Cm, C-14(N), C-14
Ground fish survey	Dab	A	Gamma spec (L)
Ground fish survey	Lesser spotted dogfish	A	Gamma spec (L)
Ground fish survey	Skates/Rays	A	Gamma spec (L)
Shellfish			
Sellafield coastal area	Edible crab	4 py	Total beta, gamma spec (L), Tc-99, Po-210, I-129 (wet)
Sellafield coastal area	Edible crab	Bulk of 1st & 3rd samples rec'd	Pu/Am/Cm, Sr-90, Pu-241, Pm-147, C-14, C-14 (N), Np-237
Sellafield coastal area	Edible crab	2nd sample rec'd	Pb-210
Sellafield coastal area	European lobster	4 py	Total beta, gamma spec (L), Tc-99, Po-210
Sellafield coastal area	European lobster	Bulk of 1st & 3rd samples rec'd	Pu/Am/Cm, Sr-90, Pu-241, Pm-147, C-14, C-14 (N), Np-237
Sellafield coastal area	European lobster	1st sample rec'd	Pb-210
Sellafield coastal area	Edible winkle	4 py	Gamma spec (L)
Sellafield coastal area	Edible winkle	A	Pu/Am/Cm, Pu-241,
Sellafield consumer	Blue (edible) mussel	4 py	Gamma spec (L)
Sellafield consumer	Blue (edible) mussel	A	Pu/Am/Cm, Pu-241, Sr-90
Sellafield consumer	Edible winkle	4 py	Gamma spec
Sellafield consumer	Edible winkle	1st & 3rd samples rec'd	Pu/Am/Cm, Sr-90, Tc-99, Pu-241, Pm-147, C-14, C-14 (N), Np-237
Sellafield consumer	Common limpet	4 py	Gamma spec
Sellafield consumer	Common limpet	A	Pu/Am/Cm, Sr-90, Pu-241, C-14, C-14 (N),
Sellafield consumer	Common limpet	1st & 3rd samples rec'd	Tc-99
Consumer 1060 Crustacea area	Norway lobster	A	Gamma spec, Pu/Am/Cm, Tc-99
St Bees - W	Edible crab	4 py	Gamma spec (L)
St Bees - W	Edible crab	A	Pu/Am/Cm
St Bees - W	European lobster	4 py	Gamma spec (L)
St Bees - W	European lobster	A	Pu/Am/Cm
St Bees Seamill	Edible winkle	4 py	Gamma spec (L), I-129 (wet)
St Bees Seamill	Edible winkle	Bulk of 1st and 3rd samples rec'd	Pu/Am/Cm, Pu-241, Sr-90, Tc-99, Pm-147, C-14, C-14 (N), Np-237
St Bees Seamill	Common limpet	4 py	Gamma spec (L)
St Bees Seamill	Common limpet	1st & 3rd samples rec'd	Po-210
St Bees Seamill	Common limpet	Annual Bulk	Pu/Am/Cm
St Bees Seamill	Blue (edible) mussel	4 py	Gamma spec (L)
St Bees Seamill	Blue (edible) mussel	2 py	Pu/Am/Cm, Pu-241
Nethertown	Edible winkle	12 py	Total beta, gamma spec (L), Tc-99
Nethertown	Edible winkle	1st, 4th,7th& 10th samples rec'd	Pu/Am/Cm, Sr-90, Pu-241, C-14, C-14 (N)
Nethertown	Edible winkle	4th & 7th samples rec'd	H-3, OBT
Nethertown	Edible winkle	April	Pm-147, Np-237
Nethertown	Edible winkle	4 py	Po-210

Location	Sample Type	Sampling Frequency	Analytical Requirement
Nethertown	Blue (edible) mussel	4 py	Total beta, gamma spec (L), Tc-99, Pu/Am/Cm
Nethertown	Blue (edible) mussel	1st & 3rd samples rec'd	H-3, OBT
Nethertown	Blue (edible) mussel	Annual Bulk	C-14, C-14(N)
Nethertown	Blue (edible) mussel	4 py	Po-210
Nethertown	Blue (edible) mussel	2nd sample rec'd	Pb-210
Whitriggs Scar	Shrimp	A	Gamma spec
Roosebeck	Pacific Oyster	2 py	Gamma spec (L)
Roosebeck	Pacific Oyster	1st sample rec'd	Pu/Am/Cm
Drigg Barn Scar	Edible winkle	4 py	Total beta, gamma spec (L), Tc-99
Drigg Barn Scar	Edible winkle	Bulk of 1st & 3rd samples rec'd	Pu/Am/Cm, Pu-241, Pm-147, C-14, C-14 (N), Np-237, Th-r/n's
Drigg Selker	Edible crab	4 py	Total beta, gamma spec (L), Tc-99
Drigg Selker	Edible crab	Annual bulk	Pu/Am/Cm, Sr-90, Pu-241
Drigg Selker	European lobster	4 py	Total beta, gamma spec (L), Tc-99
Drigg Selker	European lobster	Annual bulk	Pu/Am/Cm, Sr-90, Pu-241
Ravenglass Salmongarth	Common cockle	4 py	Total beta, gamma spec (L)
Ravenglass Salmongarth	Common cockle	1st & 3rd samples rec'd	Tc-99, Po-210
Ravenglass Salmongarth	Common cockle	Annual Bulk	Pu/Am/Cm, Sr-90, Pu-241, C-14, C-14 (N)
Ravenglass Salmongarth	Edible Mussel	4 py	Gamma spec (L)
Ravenglass Salmongarth	Edible Mussel	1st & 3rd samples rec'd	H-3, Tc-99
Ravenglass Salmongarth	Edible Mussel	Annual Bulk	Pu/Am/Cm, Pu-241
Ravenglass Estuary	Edible winkle	2 py	Gamma spec (L)
Ravenglass landing port	European Lobster	2 py	Gamma spec (L)
Tarn Bay	Edible winkle	2 py	Gamma spec (L)
Tarn Bay	Edible winkle	1st sample rec'd	Po-210
Tarn Bay	Edible winkle	Annual Bulk	Pu/Am/Cm, Pu-241
Saltom Bay	Edible winkle	4 py	Gamma spec (L), Po-210
Saltom Bay	Edible winkle	2nd sample rec'd	Pb-210
North Harrington	Edible winkle	Annual Bulk	Po-210
Whitehaven local market shop	Common cockle	2 py	Gamma spec (L)
Whitehaven local market shop	Common cockle	1st sample rec'd	Pu/Am/Cm
Whitehaven local market shop	Blue (edible) mussel	2 py	Gamma spec (L)
Whitehaven local market shop	Blue (edible) mussel	1st sample rec'd	Pu/Am/Cm, Pu-241, Sr-90
Whitehaven Area Harbour outer	Blue (edible) mussel	2 py	Gamma spec (L)
Whitehaven Area	Norway lobster	4 py	Total beta, gamma spec (L), Tc-99,
Whitehaven Area	Norway lobster	1st & 3rd samples rec'd	Pu/Am/Cm, Sr-90
Whitehaven Area	Norway lobster	Annual Bulk	C-14, C-14 (N)
Silloth	Shrimp	4 py	Gamma spec (L),
Silloth	Shrimp	1st & 3rd samples rec'd	Pu/Am/Cm, Pu-241
Silloth	Blue (edible) mussel	4 py	Gamma spec (L)
Silloth	Blue (edible) mussel	1st & 3rd samples rec'd	H-3

Location	Sample Type	Sampling Frequency	Analytical Requirement
Silloth	Blue (edible) mussel	Annual Bulk	Pu/Am/Cm
Parton	Edible crab	4 py	Gamma spec (L)
Parton	Edible crab	4 py	Po-210
Parton	Edible crab	2nd sample rec'd	U-r/n's, Pb-210, Th-r/n's
Parton	European lobster	4 py	Gamma spec (L)
Parton	European lobster	4 py	Po-210
Parton	European lobster	2nd sample rec'd	U-r/n's, Pb-210, Th-r/n's
Parton	Blue (edible) mussel	4 py	Po-210
Parton	Blue (edible) mussel	1st sample rec'd	Pb-210
Parton	Edible winkle	4 py	Gamma spec (L)
Parton	Edible winkle	4 py	Po-210
Parton	Edible winkle	1st & 3rd samples rec'd	U-r/n's, Th-r/n's
Parton	Edible winkle	1st sample rec'd	Pb-210
Parton	Edible winkle	Annual bulk	Pu/Am/Cm, Pu-241
Haverigg	Common cockle	2 py	Gamma spec (L)
Millom	Blue (edible) mussel	4 py	Gamma spec (L)
Milllom	Blue (edible) mussel	Annual bulk	Pu/Am/Cm
Morecambe Bay (Flookburgh)	Shrimp	4 py	Gamma spec (L)
Morecambe Bay (Flookburgh)	Shrimp	Bulk of 1st & 3rd samples rec'd	Pu/Am/Cm, Pu-241, Tc-99
Morecambe Bay (Flookburgh)	Shrimp	Annual Bulk	C-14, C-14 (N)
Morecambe Bay (Flookburgh)	Common cockle	4 py	Gamma spec (L)
Morecambe Bay (Flookburgh)	Common cockle	1st and 3rd samples rec'd	Tc-99, Po-210
Morecambe Bay (Flookburgh)	Common cockle	Annual Bulk	Pu/Am/Cm, Sr-90, Pu-241, C-14, C-14 (N)
Morecambe	Blue (edible) mussel	Bulk of 1st and 3rd samples rec'd	Tc-99
Barrow	Edible crab	4 py	Gamma spec (L)
Barrow	Edible crab	Annual bulk	Pu/Am/Cm
Barrow	European lobster	4 py	Total beta, gamma spec (L)
Barrow	European lobster	Annual Bulk	Tc-99
Isle of Man Irish Sea	European lobster	4 py	Total beta, gamma spec (L)
Isle of Man Irish Sea	European lobster	1st and 3rd samples rec'd	Tc-99
Isle of Man Irish Sea	Escalop	4 py	Gamma spec (L)
Isle of Man Irish Sea	Escalop	1st sample rec'd	Pu/Am/Cm
Aberdeen north North Sea	Norway lobster	2 py	Gamma spec
Aberdeen north North Sea	Norway lobster	A	Tc-99
Aberdeen north North Sea	Norway lobster	1st sample rec'd	Pu/Am/Cm
Wirral	Shrimp	2 py	Gamma spec (L), H-3
Wirral	Shrimp	Annual Bulk	Tc-99
River Dee	Common cockle	4 py	Gamma spec (L)
River Dee	Common cockle	Bulk of 1st and 3rd samples rec'd	Tc-99
River Dee	Common cockle	Annual Bulk	Pu/Am/Cm
Ribble Estuary	Shrimp	2 py	Gamma spec (L), Th-r/n's
Ribble Estuary	Shrimp	1st sample rec'd	Pu/Am/Cm, Tc-99, C-14, C-14 (N), Np-237

Location	Sample Type	Sampling Frequency	Analytical Requirement
Ribble Estuary	Common cockle	2 py	Gamma spec (L)
Ribble Estuary	Common cockle	Annual Bulk	Pu/Am/Cm, Th-r/n's
Ribble Estuary	Blue (edible) mussel	2 py	Gamma spec (L), Th-r/n's.
Fleetwood Irish Sea	Squids	A	Gamma spec
Knott End	Common cockle	2 py	Gamma spec (L)
Knott End	Common cockle	1st sample rec'd	Pu/Am/Cm
North Anglesey	Edible crab	A	Pu/Am/Cm, Tc-99
North Anglesey	European lobster	A	Tc-99
Conwy	Blue (edible) mussel	2 py	Gamma spec (L), C-14, C-14 (N)
Conwy	Blue (edible) mussel	Annual Bulk	Pu/Am/Cm
Southern North Sea - Dutch landed	Common cockle	2 py Bulk	Gamma spec (L)
Southern North Sea - Dutch landed	Common cockle	A	Gamma spec (L), Tc-99, Pu/Am/Cm
Southern North Sea – Danish/Dutch landed	Blue (edible) mussel	2 py Bulk	Gamma spec
Southern North Sea – Danish/Dutch landed	Blue (edible) mussel	A	Total beta, gamma spec
Southern North Sea – Danish/Dutch landed	Blue (edible) mussel	1st sample rec'd	Pu/Am/Cm
Lowestoft Southern North Sea	Common cockle	2 py Bulk	Gamma spec (L)
Lowestoft Southern North Sea	Common cockle	A	Gamma spec, Pu/Am/Cm, Th-r/ns
Lowestoft Southern North Sea	Blue (edible) mussel	2 py	Gamma spec (L)
Lowestoft Southern North Sea	Blue (edible) mussel	1st sample rec'd	Pu/Am/Cm, Tc-99
Cromer	Edible crab	A	Gamma spec (L)
English Channel - east	Escalop	2 py	Gamma spec (L)
English Channel - east	Escalop	1st sample rec'd	Pu/Am/Cm, C-14, C-14(N)
English Channel - west	Edible crab	2 py	Gamma spec (L)
English Channel - west	Edible crab	1st sample rec'd	Pu/Am/Cm, C-14, C-14(N)
English Channel - west	European lobster	2 py	Gamma spec (L)
English Channel - west	European lobster	A	Tc-99
English Channel - west	Escalop	2 py	Gamma spec (L)
English Channel - west	Escalop	1st sample rec'd	Pu/Am/Cm, C-14, C-14(N)
South Gare	Edible winkle	2 py	Po-210
South Gare	Edible winkle	1st sample rec'd	Pb-210
Ground fish survey	Spiney spider crab	A	Gamma spec (L)
Ground fish survey	Common cuttle fish	A	Gamma spec (L)
Aquatic Plants			
England			
St Bees	*Porphyra*	Q	Total beta, gamma spec (L)
St Bees	*Porphyra*	Bulk of 1st & 3rd quarters	Pu/Am/Cm, Sr-90, Tc-99, Pu-241
St Bees	*Porphyra*	Annual Bulk	C-14, C-14(N)
Sellafield coastal	Dulse	B	Gamma spec (L)
Sellafield coastal	Dulse	Annual Bulk	Pu/Am/Cm
Braystones south	*Porphyra*	Q	Gamma spec (L)
Braystones south	*Porphyra*	Bulk of 1st & 3rd samples rec'd	Pu/Am/Cm, Pu-241
Seascale	*Porphyra*	W	Gamma spec (W)
Marshside Sands	Samphire	A	Gamma spec (L)
Rabbit Cat How	Samphire	A	Gamma spec (L), Tc-99
Cockerham Marsh	Samphire	A	Total beta, gamma spec (L)

Location	Sample Type	Sampling Frequency	Analytical Requirement
Wales			
South Wales manufacturer A	Laverbread	Q	Gamma spec (L)
South Wales manufacturer C	Laverbread	Q	Gamma spec (L)
South Wales manufacturer D	Laverbread	Q	Total beta, gamma spec (L)
South Wales manufacturer E	Laverbread	A	Gamma spec (L)
Sea to land transfer investigations			
Gosforth Consumer B	Potatoes	A	Gamma spec (L), Tc-99
Gosforth Consumer B	Vegetables	3py	Gamma spec (L), Tc-99
Gosforth Consumer B	Soil	A	Gamma spec (L), Tc-99
Calder Bridge Consumer R	Potatoes	A	Gamma spec (L), Tc-99
Calder Bridge Consumer R	Vegetables	3py	Gamma spec (L), Tc-99
Calder Bridge Consumer R	Soil	A	Gamma spec (L), Tc-99
Sellafield porphyra composter	Potatoes	A	Gamma spec (L), Tc-99
Sellafield porphyra composter	Vegetables	4py	Gamma spec (L), Tc-99
Sellafield porphyra composter	Soil	A	Gamma spec (L), Tc-99

Abbreviations

Sampling Frequency

A	Annual
B	Biannual
Q	Quarterly
M	Monthly
W	Weekly
py	number of samples per year (unspecified periodicity)
rec'd	Received

Analytical Requirement

Total beta	Total beta radioactivity with reference to a K-40 standard
H-3	Total tritium radioactivity
OBT	Organically Bound Tritium radioactivity
Gamma spec (H)	Gamma spectroscopy on dried sample with LoD of 1Bq/kg (wet weight) for Cs-137
Gamma spec (L)	Gamma spectroscopy on dried sample with LoD of 0.1 Bq/kg (wet weight) for Cs-137
Gamma spec (W)	Gamma spectroscopy on wet sample with LoD of 1Bq/kg for Cs-137
C-14 (N)	Amount of naturally occurring C-14 in sample (see RIFE-8, Appendix 6.1)
I-129 (dry)	Gamma spectroscopy on dried sample with I-129 LoD of 0.1 Bq/kg (wet weight)
I-129 (wet)	Gamma spectroscopy on wet sample with I-129 LoD of 0.1 Bq/kg (wet weight)

The following samples have been removed from the programme for 2011 due to insufficient historical data

Location	Sample Type	Sampling Frequency	Analytical Requirement
R Derwent	Sea trout (brown trout)	A	Gamma spec (L)
R Ehen	Sea trout (brown trout)	A	Gamma spec (L)
R Duddon	Sea trout (brown trout)	A	Gamma spec (L)
R Kent	Sea trout (brown trout)	A	Gamma spec (L)

APPENDIX 6

Food Standards Agency Terrestrial Monitoring for Sellafield for 2009

Location	Sample Type	Sampling Frequency	Analytical Requirement
Sellafield			
15 farms	Milk	Monthly	Gamma Scan
15 farms	Milk	Quarterly	HTO, OT-3, C-14, Total Cs
4 farms	Milk	Weekly	I-131
		Quarterly	Sr-90, I-129, Pu, Pu-241, Am-241
11 farms	Milk	Annually	Sr-90, I-129
All farm bulk	Milk	6 monthly	Tc-99
1 dairy	Milk	Monthly	Gamma scan
		Quarterly	HTO, OT-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241
10 samples	Meat & Meat Products	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, Tc-99, I-129, Total Cs, Pu, Pu-241, Am-241, Isotopic U (3 samples only)
2 samples	Meat & Meat Products (wild)	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241
1 sample	Eggs	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241
13 samples	Crops	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241
3 samples	Crops	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, I-129, Total Cs
1 sample	Crops	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, Tc-99, I-129, Total Cs
1 sample	Crops	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, Tc-99, I-129, Total Cs, Pu, Pu-241, Am-241
1 sample	Crops	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241, Isotopic U
1 sample	Crops	Annually	Gamma scan, HTO, OT-3, C-14, Sr-90, I-129, Total Cs, Isotopic U
2 samples	Grass	Annually	Tc-99, Ru-106, Ce-144

Location	Sample Type	Sampling Frequency	Analytical Requirement
3 samples	Grass	Annually	Gamma scan
3 samples	Soil	Annually	Gamma scan
1 sample	Soil	Annually	Isotopic U
Ravenglass Estuary			
3 farms	Milk	Monthly	Gamma scan
		Quarterly	Total H-3, C-14, Sr-90, I-129, Pu, Pu-241, Am-241
		All farm bulk 6 monthly	Tc-99
8 samples	Meat & Meat products	Annually	Gamma scan. Total H-3, C-14, Sr-90, 99Tc, I-129, Total Cs, Pu, Pu-241, Am-241, Isotopic U (1 sample only)
8 samples	Crops	Annually	Gamma scan, Total H-3, C-14, Sr-90, Tc-99, I-129, Total Cs, Pu, Pu-241, Am-241
2 samples	Crops	Annually	Tc-99, Isotopic U
2 samples	Grass	Annually	Tc-99
1 sample	Soil	Annually	Isotopic U
Drigg			
1 farm	Milk	Monthly	Gamma scan
		Quarterly	Total H-3, C-14, Sr-90, I-129, Pu, Pu-241, Am-241
		Bi-annual	Tc-99
4 samples	Meat & Meat Products	Annually	Gamma scan, Total H-3, C-14, Sr-90, Tc-99, I-129, Total Cs, Pu, Pu-241, Am-241
1 sample	Eggs	Annually	Gamma scan, Total H-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241
2 samples	Crops	Annually	Gamma scan, Total H-3, C-14, Sr-90, I-129, Total Cs, Pu, Pu-241, Am-241
2 samples	Crops	Annually	Gamma scan, Total H-3, C-14, Sr-90, Tc-99, I-129, Total Cs, Pu, Pu-241, Am-241
2 samples	Grass	Annually	Tc-99, Isotopic U
1 sample	Soil	Annually	Isotopic U

APPENDIX 7

Scottish Environment Protection Agency Aquatic Monitoring in Scotland in Relation to Sellafield

Location	Sample Type	Sampling Frequency	Analytical Requirement
Instrumental Monitoring			
Bladnoch	-	4	Gamma dose rate
Carsluith	-	4	Gamma dose rate
Cutters Pool	-	4	Gamma dose rate
Gardenburn	-	1	Gamma dose rate
Garlieston	-	4	Gamma dose rate
Innerwell Fisheries	-	4	Gamma dose rate
Kippford Merse	-	1	Gamma dose rate
Kippford Slipway	-	4	Gamma dose rate
Kirkconnell Merse	-	1	Gamma dose rate
Kirkcudbright Merse	-	4	Gamma dose rate
Palnackie	-	1	Gamma dose rate
Piltanton Burn	-	4	Gamma dose rate
Rascarral Bay	-	4	Gamma dose rate
Skyreburn	-	4	Gamma dose rate
Seafood			
Cutters Pool	Common Limpet	1	Gamma spec, Po-210
Islay	Crab	1	Gamma spec
Islay	Scallops	1	Gamma spec
Kirkcudbright	Crab	4	Gamma spec, Tc-99 & one for Po-210/Pb-210, Pu-241
Kirkcudbright	Crab	Annual Bulk	Am/Pu, C-14, Sr-90
Kirkcudbright	Lobster	4	Gamma spec, Tc-99 & one for Po-210/Pb-210, Pu-241
Kirkcudbright	Lobster	Annual Bulk	Am/Pu, C-14, Sr-90
Kirkcudbright	Winkles	4	Gamma spec & one for Po-210/Pb-210
Kirkcudbright	Winkles	Annual Bulk	Am/Pu, Sr-90, Tc-99
Lewis	Mussels	1	Gamma spec
North Solway	Cockles	1	Gamma Am/Pu
North Solway	Mussels	4	Gamma, H-3
North Solway	Mussels	Annual Bulk	Am/Pu, C-14, Sr-90, Pu-241
Skye	Lobster	1	Gamma spec, Tc-99
Skye	Mussels	1	Gamma
West Coast Sea Products	Plaice	4	Gamma
West Coast Sea Products	Plaice	Annual Bulk	Am/Pu, C-14, Tc-99
West Coast Sea Products	Queens	4	Gamma
West Coast Sea Products	Queens	Annual Bulk	Am/Pu, Tc-99
West Coast Sea Products	Scallops	4	Gamma
West Coast Sea Products	Scallops	Annual Bulk	Am/Pu, Tc-99

Seawater			
Auchencairn	Seawater	4	Gamma spec, H-3, salinity
Knock Bay	Seawater	4	Gamma spec, H-3, salinity
Seaweed			
Aberdeen Harbour	Seaweed	1	Gamma spec, Tc-99
Auchencairn	Seaweed	4	Gamma spec, Tc-99
Campbeltown	Seaweed	1	Gamma spec, Tc-99
Garlieston	Seaweed	4	Gamma spec, Tc-99
Islay	Seaweed	1	Gamma spec, Tc-99
Lerwick, Shetland	Seaweed	1	Gamma spec, Tc-99
Lewis	Seaweed	1	Gamma spec, Tc-99
Port William	Seaweed	4	Gamma spec, Tc-99
Sediment			
Campbeltown	Sediment	1	Gamma spec
Cutters Pool	Sediment	1	Gamma spec
Gardenburn	Sediment	1	Gamma spec, Am/Pu
Innerwell Fisheries	Sediment	1	Gamma spec
Kippford Merse	Sediment	1	Gamma spec, Am/Pu
Kippford Slipway	Sediment	1	Gamma spec, Am/Pu
Kirkconnell Merse	Sediment	1	Gamma spec, Am/Pu
Palnackie	Sediment	1	Gamma spec, Am/Pu
Rascarral Bay	Sediment	1	Gamma spec
Skyreburn	Sediment	1	Gamma spec

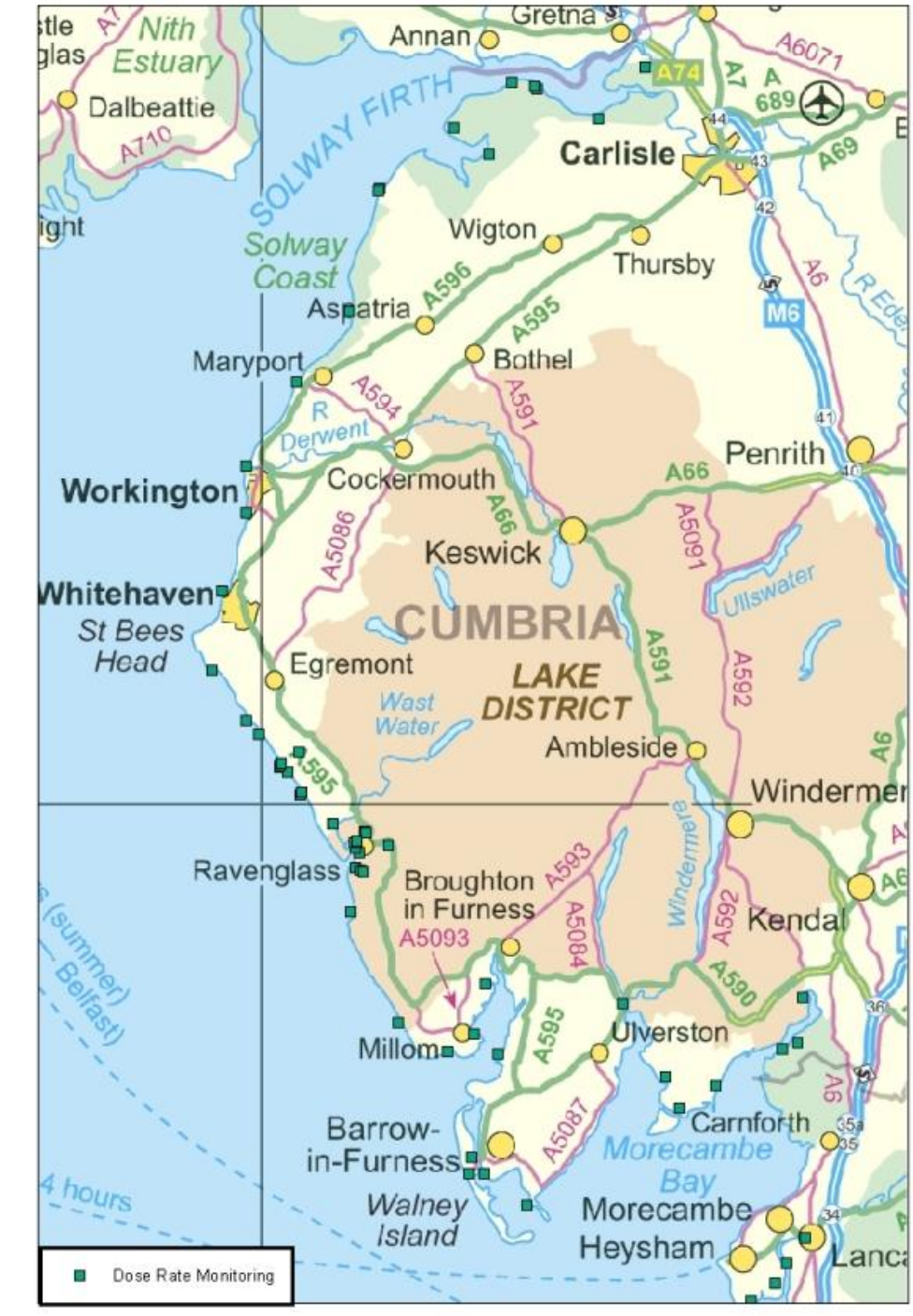
The samples listed below have been transferred from the FSA to SEPA for collection and analysis.

Location	**Sample Type**	**Sampling Frequency**	**Analytical Requirement**
Fresh water fish			
Loch Dee (Dumfries and Galloway)	Brown trout	A	Gamma spec (L)
Seafood			
West of Scotland	European mackerel	A	Gamma spec (L)
West of Scotland	European mackerel	A	Gamma spec (L)
Scotland west coast farmed salmon	North Atlantic salmon	A	Gamma spec (L)
Peterhead Minch	Herring	A	Gamma spec (L)
Peterhead Minch	Herring	2 py	Bulk for Gamma spec (L)
Peterhead Minch	European mackerel	A	Gamma spec (L)
Peterhead Minch	European mackerel	2 py	Bulk for Gamma spec (L)
Peterhead Minch	European mackerel	1st sample rec'd	Pu/Am/Cm, Sr-90, C-14(N), C-14
Shetland (Bressay)	Unspecified fish	2 py	Gamma spec (L)
Shetland (Bressay)	Unspecified fish	1st sample rec'd	Pu/Am/Cm, Sr-90
Shetland (Bressay)	Unspecified fish - Fish oil	2 py	Gamma spec (L)
Aberdeen north North Sea	Haddock	A	C-14(N), C-14

Aberdeen north North Sea	Haddock	2 py	Gamma spec (L)
Aberdeen north North Sea	Haddock	1st sample rec'd	Pu/Am/Cm
Aberdeen north North Sea	Herring	A	Gamma spec (L)
Aberdeen north North Sea	Herring	2 py	Bulk for Gamma spec (L)
Aberdeen north North Sea	European plaice	2 py	Gamma spec (L)
Aberdeen north North Sea	Round fish - white	2 py	Gamma spec (L)
Aberdeen north North Sea	Round fish - white	1st sample rec'd	Pu/Am/Cm, Sr-90
Aberdeen north North Sea	Norway lobster	2 py	Gamma spec
Aberdeen north North Sea	Norway lobster	A	Tc-99
Aberdeen north North Sea	Norway lobster	1st sample rec'd	Pu/Am/Cm

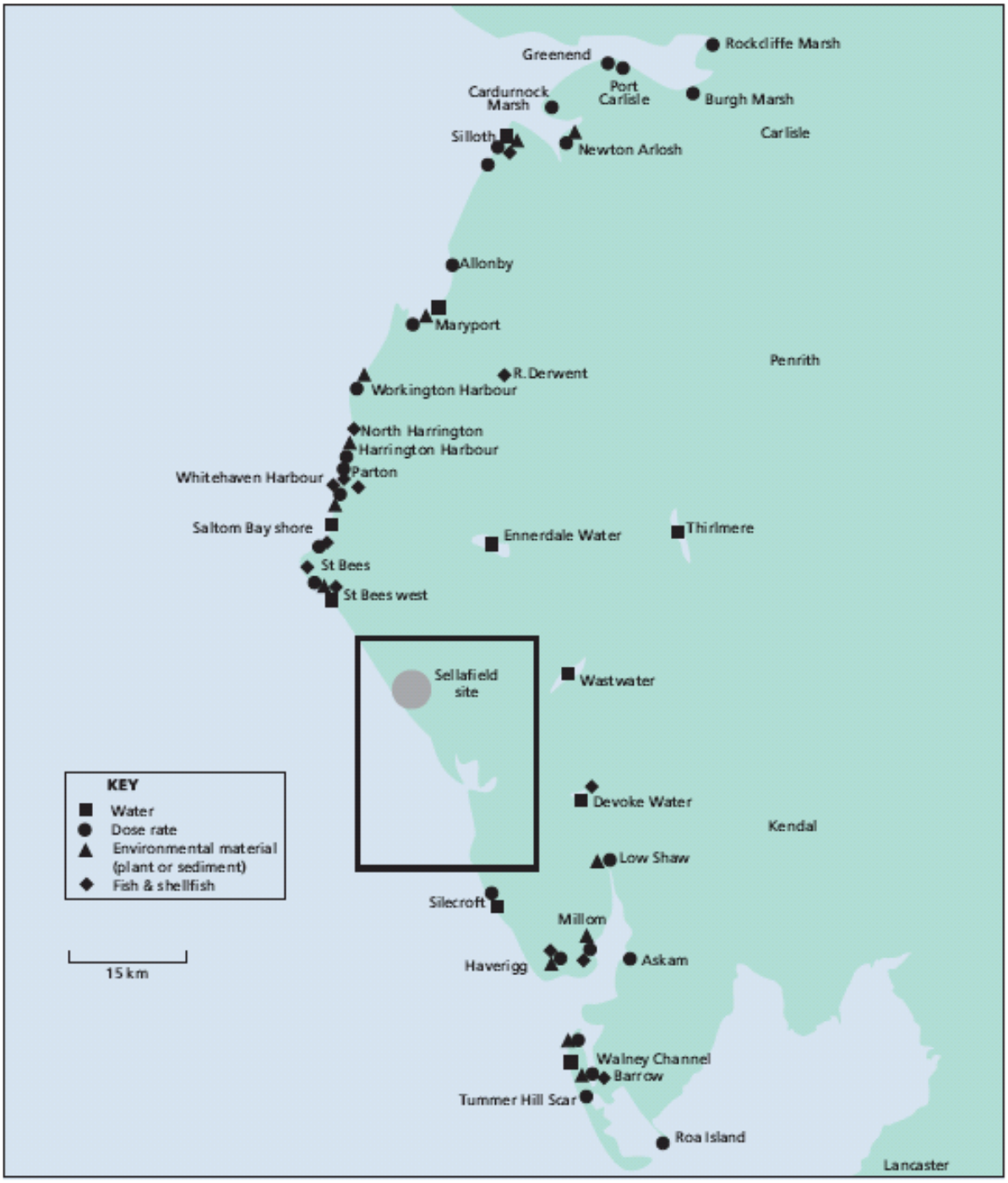
APPENDIX 8

Environment Agency Monitoring Locations in the vicinity of Sellafield.



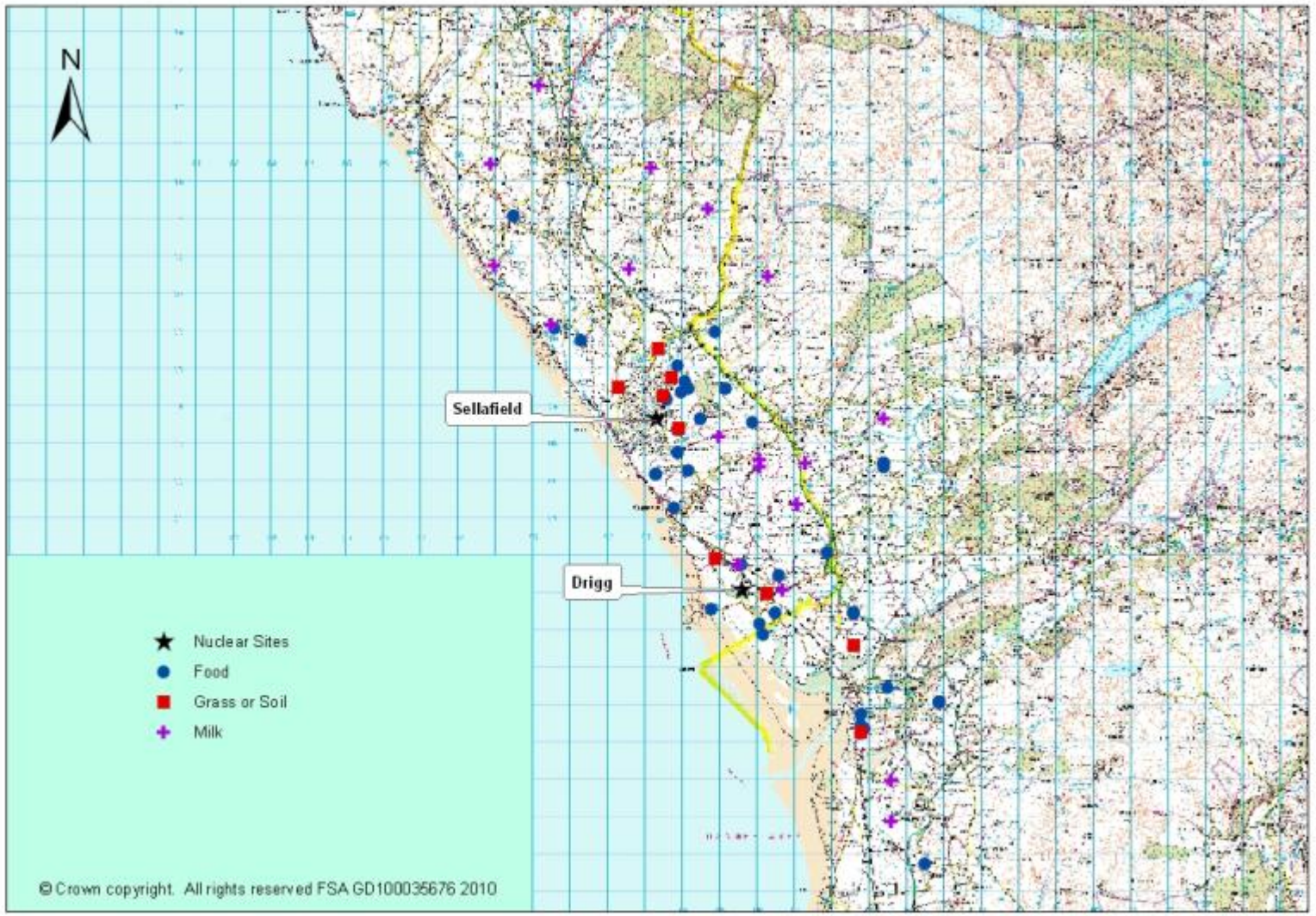
APPENDIX 9

Food Standards Agency Monitoring locations in Cumbria in 2009 [excluding farms]



APPENDIX 10

Food Standards Agency Terrestrial Sampling Locations for 2009



Appendix 11

LILLYHALL SAMPLING AND MONITORING PROGRAMME

Sample / Monitoring Type	Location / Frequency	Sampling / Monitoring Method and Analysis
Groundwater	**Quarterly** at downstream boreholes WMBH2 (Easting 302532, Northing 524693) and WMBH11 (Easting 302321, Northing 524920). **Annually** at upstream boreholes WMBH9 (Easting 303081, Northing 524685) and WMBH12 (easting 302902, Northing 525187).	Spot sample. Each sample to be analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides).
Leachate	**Annual** at the main combined flow of leachate into the treatment plant (pre-treatment) (Easting 302438, Northing 524963).	Spot sample. Each sample to be analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides).
Treatment plant sludge	**Annual** sample from the treatment plant, representative of the bulk sludge, samples points at: ▪ Easting 302438, Northing 524934 and ▪ Easting 302353, Northing 524925	Composite sample. Each sample to be analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides).
Discharge to sewer	**Quarterly** sample from the treatment plant final discharge point to sewer (Easting 302360, Northing 5240908).	24- hour flow proportional sample. Each sample to be analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides).
Surface water within the site	**Bi-annual** sample from the lagoon receiving water from the vehicle wheel wash facility (Easting 302417, Northing 524868).	Spot sample. Each sample to be analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides).
Surface water	**Bi-annual** sample from Distington Beck downstream of the site, Ref LIWP00PD (Easting 302500, Northing 524669).	Spot sample. Each sample to be analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides). .
Grass / Herbage	**Annual** sample (in quarter 3) to be taken at 4 locations adjacent to the site boundary, ▪ WMBH12 (North) (Easting 302902, Northing 525187) ▪ WMBH9 (East) (Easting 303081, Northing 524685) ▪ WMBH3 (South) (Easting 302574, Northing 524516) ▪ GBH13 (West) (Easting 302562, Northing 525067).	Sample of trimmed unwashed grass/herbage to within 10mm of the soil surface from a known area. Sampling of leaf litter and soil should be avoided and areas of poor vegetation cover or dominance of woody species should be avoided. Each sample to be bulked and analysed for total alpha and beta, tritium, gamma spec (report all detected radionuclides). Results shall be reported as activity concentration and loading (Bq/kg and Bq/m^2).
Gamma dose rate monitoring	**Quarterly** dose rate monitoring at: (i) four locations where the public can gain closest access to the waste to the NE, NW, SE and SW of the premises at points: A (Easting 302568, Northing 525077) B (Easting 303027, Northing 525065) C (Easting 303100, Northing 524665) D (Easting 302589, Northing 524665) (ii) at the premises exit to Joseph Noble Road (monitoring point E as defined in drawing 153M2671 Dated 14/03/11).	Using continuous measurement with a thermoluminescent dosimeter (measurement of TLD by Approved Dosimetry Service). Or a spot dose rate measurement made in accordance with TGN-M5 (Her Majesty's Inspectorate of Pollution, Technical Guidance Note (Monitoring) M5, Routine Measurement of Gamma Ray Air Kerma Rate in the Environment. HMSO, September 1995.). Measurements to be made at 1 metre above ground level.