

# Strategic Environmental Assessment

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## Site Specific Baseline **Sellafield**

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**December 2012**

An Environmental and Sustainability Report was published by the NDA as part of the Strategic Environmental Assessment (SEA) of the NDA Strategy. It was produced in compliance with the SEA Directive (2001/42/EC) and transposing regulations (S.I.1633, 2004).

The following pages contain specific baseline information, and maps, for the Sellafield site. This information was used in the preparation of the Environmental and Sustainability Report and regularly updated information will be used as part of monitoring measures to identify trends in potential environmental impacts. A short introduction is followed by a table containing the current baseline information, organised by sustainability headings. The final section includes information about future developments and environmental issues.

The NDA and Sellafield Ltd are committed to openly sharing information and making it accessible to all. In making this non-confidential environmental and sustainability information available we believe that it will provide a useful ongoing resource to the general public and stakeholders.

# Site Specific Baseline – Sellafield

December 2012

Date of Amendment	Section(s) Amended	Details of Amendment
June 2011	All	Document updated and re-issued.
November 2011	Air Quality, Cultural Heritage, Health & Safety, Water Resource & Quality.	The sections listed have been updated to include 2010 data.
July 2012	Introduction, Air Quality, Global Climate Change & Energy, Biodiversity Flora & Fauna, Water Resource & Quality, Waste, Land Use & Material Assets, Health & Safety.	The sections listed have been updated to include 2011 data.
December 2012	Waste, Economy, Skills and Society, Noise and Vibration.	The sections listed have been updated to include 2011 data.

# Site Specific Baseline for Sellafield (including Calder Hall and Windscale)

## Sellafield

The Sellafield site, situated in West Cumbria and covering some 276 hectares, undertakes nuclear fuel cycle activities. Situated within the Sellafield site is the Calder Hall nuclear power station, covering some 16 hectares, which operated between 1956 and 2003. The Windscale nuclear licensed site, which includes the Windscale Piles, prototype Windscale Advanced Gas Reactor (WAGR) and shielded facilities for the examination and handling of irradiated fuel is a 13.4 hectare site adjacent to the Sellafield site. The management of Windscale was taken over by Sellafield Ltd from UKAEA in 2008.

Commercial operations at the Sellafield site are ongoing in the form of receipt of spent fuel from UK reactors and overseas reactors and Magnox and Oxide fuel reprocessing. In parallel to these ongoing fuel cycle activities the site is undertaking decommissioning and legacy waste management activities. According to the current Magnox Operating Plan (MOP9) the reprocessing of fuel from the Magnox reactors is expected to take until 2017 or later. Reprocessing is the only proven technique for managing wetted Magnox fuel but the NDA are currently reviewing potential alternative contingency strategies.

The NDA has announced its decision to complete the current reprocessing contracts through Thorp, as the most viable and cost-effective strategy for managing oxide fuel. Thorp reprocessing is scheduled to be completed in 2018 and the post operational clean out phase will follow. This strategy is reflected in the Sellafield Plan.

The NDA also announced the closure of Sellafield Mixed Oxide Plant (SMP) in August 2011, following the impact on the Japanese nuclear industry of the earthquake and tsunami in March 2011.

Clean up at Sellafield began many years ago but has increased in significance in recent years with retrieval of most legacy wastes due for completion in 2038. Commercial reprocessing operations are anticipated to run to 2018 with Pu and U storage due to go beyond this date. Interim storage of waste, pending the availability of final disposal routes, will run until 2040 when it is currently assumed the UK ILW repository is available and the export of interim stored waste for Sellafield can commence.

The Calder Hall reactors shut down in 2003 after operating for over 46 years. Reactor defuelling in accordance with the Sellafield Plan is planned to finish in 2015. Interim care and maintenance is planned to be completed in 2032. This takes this part of the site to a state where it may be handed over for demolition and subsequent long term care and maintenance of the remaining four reactor safestores. The demolition phase is expected to take 5 years to complete.

The Windscale Piles ceased operation following a fire in Pile 1 in 1957 and decommissioning commenced in 1982. Pile 1 will be decommissioned and demolished down to the 35m level. The remaining structure will then be placed under care and maintenance along with the Pile 2 remaining structure. Following final decommissioning of the pile reactors, the remaining pile chimney structures will be demolished.

## Site End State Assumption

The NDA stakeholders' consultation recommended considering the Sellafield site as a number of discrete zones for the purposes of defining end uses and end states. Having reviewed these, the NDA considers that these could be simplified into two conceptual zones:

- An 'inner zone' where it is anticipated that the remediation of the site to levels that would allow delicensing will be impractical and present unacceptable social and environmental consequences or would not present value for money. This area is anticipated to require long term Institutional Control.
- An 'outer zone' where it is anticipated that the remediation of the site to levels that would allow delicensing will be practical once national waste repositories are available (allowing stores to be emptied and buildings to be demolished) and would not present unacceptable social and environmental consequences, and would present value for money, if there is an identified business need. It is assumed that all above ground structures would be removed to ground level.

Further work to better define the boundaries of the zones is required and over time this boundary may change in the light of developing information, technology and activities on the site. However, it is currently envisaged that the inner zone would include the Separation Area and the Windscale Piles. The objective is to maximise the area of the site that falls within the outer zone.

## Current Environmental Baseline

**Table 10: Baseline Data across all topics for Sellafield**

SEA Objective	Key Environmental Baseline			Source																					
Air Quality	<p>The Sellafield site is located in a relatively rural location in Cumbria. The concentration of all pollutants required to be monitored as part of the National Air Quality Strategy (NAQS) are currently below the objectives set out in NAQS and below values at which adverse health effects are likely to occur, therefore there is no requirement for an Air Quality Management Area (AQMA) plan. Non-radioactive emissions are generated on the site through the operation of plants and use of vehicles; the former are regulated under the Environmental Permitting Regulations 2010 where applicable.</p> <p>The Sellafield site encompasses the Calder Hall and Windscale sites and as such the radionuclide discharges are assessed together, although the majority of discharges are from Sellafield. The amount of radioactivity discharged to the atmosphere from the Sellafield and Calder Hall facility during 2011 included:</p> <table border="1"> <thead> <tr> <th>Radionuclide or Group of Radionuclides</th> <th>Annual Discharge TBq</th> <th>Percentage of limit %</th> </tr> </thead> <tbody> <tr> <td>Total Alpha</td> <td>8.98E-05</td> <td>10.2</td> </tr> <tr> <td>Total Beta</td> <td>1.28E-03</td> <td>3.0</td> </tr> <tr> <td>Tritium</td> <td>9.79E+01</td> <td>8.9</td> </tr> <tr> <td>Carbon-14</td> <td>3.96E-01</td> <td>12.0</td> </tr> <tr> <td>Krypton-85</td> <td>6.43E+04</td> <td>14.6</td> </tr> <tr> <td>Cesium-137</td> <td>9.34E-05</td> <td>1.6</td> </tr> </tbody> </table>	Radionuclide or Group of Radionuclides	Annual Discharge TBq	Percentage of limit %	Total Alpha	8.98E-05	10.2	Total Beta	1.28E-03	3.0	Tritium	9.79E+01	8.9	Carbon-14	3.96E-01	12.0	Krypton-85	6.43E+04	14.6	Cesium-137	9.34E-05	1.6			<p>Copeland Borough Council website : Sustainability appraisal of the Copeland Core Strategy, Air quality ;</p> <p>SL statutory returns provided under authorisation KP3690SX;</p> <p>Environment agency et al. (2011) <i>Radioactivity in Food and the Environment 2011</i></p>
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	Doses from environmental measurements to the critical group (a group or representative individual who receive the largest dose from artificially produced radionuclides due to their habits, diet and where they spend their time) in 2011 were calculated as 0.010 mSv/y or 1% of the public dose limit of 1 mSv/y.	
<b>Global Climate Change and Energy</b>	<p>In 2011, the Sellafield nuclear site emitted 281,000 tonnes of CO<sub>2</sub> and equivalents, a significant amount arising as a result of the consumption of 411,000 MWh of energy, compared to 223,000 tonnes of CO<sub>2</sub>, and 410,000 MWh of energy in 2010.</p> <p>The Sellafield site is located between 5 m and 50 m Above Ordnance Datum (AOD) along the Cumbria coastline. The site is generally protected from coastal flooding by cliffs, Ehen shingle spit and a railway embankment. However, coastal erosion and sea level rise has the potential to affect the southern end of the Sellafield site within the next 100 years if existing defences are not maintained.</p>	Sellafield Ltd NSP Returns 2011 & 2010; Nexia Solutions (2008) <i>Position Paper on Climate and Landscape Change Effects at NDA Sites</i>
<b>Biodiversity, Flora and Fauna</b>	<p>There are no statutory designated sites of nature conservation interest within 2 km of the Sellafield site. The nearest is Low Church Moss Site of Special Scientific Interest (SSSI), which lies just beyond this distance, to the north-west of Sellafield.</p> <p>The confluence of the River Ehen and the River Calder is located adjacent to the south of Sellafield. The upper reaches of the River Ehen are designated as a Special Area of Conservation (SAC), primarily by supporting freshwater pearl mussels. Though the presence of freshwater pearl mussel is the primary reason for site selection, the River Ehen also qualifies as a SAC by supporting salmon</p> <p>Although the nearest boundary of the River Ehen SAC lies approximately 10 km from Sellafield, migrating salmon pass adjacent to the site when they travel through the River Ehen/Calder confluence during their passage to higher reaches upstream.</p> <p>South of the site there is a managed habitat for Natterjack Toads, a European Protected Species. This is monitored by the Amphibian and Reptile Conservation Trust.</p> <p>A generic assessment of the impacts of the radioactive discharges on wildlife from the UK's nuclear facilities concluded that the chronic dose rate guideline was not exceeded for any of the assessed marine or terrestrial organisms as a result of current discharges. Furthermore, the estimated doses to wildlife were below the level at which the effects could be observed.</p> <p>The supporting figure highlights the context of the nuclear licensed site and its immediate surroundings with respect to designated areas of conservation.</p>	MAGIC website <a href="http://www.magic.defra.gov.uk">www.magic.defra.gov.uk</a> ;  Environment Agency (2002) <i>Impact Assessment of Ionising Radiation on Wildlife</i>
<b>Landscape and Visual</b>	<p>The Sellafield site (including Calder Hall and Windscale) is adjacent to the Irish Sea Coast and the River Calder, at an altitude of between 5 m - 50 m above Ordnance Datum (AOD).</p> <p>The site falls within the West Cumbria Coastal Plain and is identified as an area of varied open coastline of mudflats, shingle and pebble beaches with localised sections of dunes, sandy beaches and sandstone cliffs. The Sellafield complex is often visible as a relatively large industrial site within the open coastal landscape although the demolition of the Calder Hall cooling towers in September 2007 has significantly reduced the site's visual impact.</p> <p>Local (up to 2 km) views of the site are available from parts of Seascale, the Cumbria Coastal Way, and other publicly accessible viewpoints.</p>	MAGIC website <a href="http://www.magic.defra.gov.uk">www.magic.defra.gov.uk</a>
<b>Cultural Heritage</b>	<p>There are no archaeology or historical features identified within, or immediately adjacent to the site, although Calder Hall may be of historical interest as it was the first commercial nuclear power station in the world. For this reason in the 2006 Strategy, the NDA committed to commission a project to evaluate the feasibility of preserving Calder Hall reactor 1. However, following the completion of this project, the NDA concluded that such a proposal did not represent value for money and therefore declined to fund further work on this.</p> <p>A Scheduled Ancient Monument (SAM), stone circle is located some 2 km to the south at Seascale Farm.</p>	MAGIC website <a href="http://www.magic.defra.gov.uk">www.magic.defra.gov.uk</a>

	<p>It is a reasonable assumption that any earlier archaeological remains (prior to previous industrial use) on the site will have been destroyed during the construction of the deep basements and foundations of the current facilities or those operations under the Ministry of Supply that predate the current usage.</p>																						
<b>Groundwater, Geology and Soils</b>	<p>An estimated 1,600 m<sup>3</sup> of soil is contaminated with radioactive material to Intermediate Level Waste (ILW) levels. Much of this contamination reflects the industrial activities that have taken place on the site. Contamination is mainly located in the centre of the Sellafield site. The site also overlies an aquifer in the underlying sandstone geology which is known to be significantly contaminated to the southwest due to the migration of contamination from the site.</p> <p>As well as the estimated 1,600 m<sup>3</sup> of soil contaminated to ILW levels there is also estimated to be just over 1,000,000 m<sup>3</sup> of soil contaminated to LLW levels. There is also estimated to be some 11,800,000 m<sup>3</sup> of soil contaminated with radioactive material which will require management as High Volume Very Low Level Waste (HVLLW).</p> <p>Since 2006, the application of enhanced beach monitoring near Sellafield using the techniques developed for Dounreay has identified a number of contaminated finds on local beaches. These are more diverse and generally contain less active radionuclide material than the material identified at Dounreay. Arrangements are in place to monitor for these items and recover those which are found.</p> <p>The groundwater is considered to be good chemical status and good quantitative status in accordance with the Water Framework Directive.</p>	<i>NDA (2010) Radioactive Materials Not Reported in the 2010 Radioactive Waste Inventory; Environment Agency (2009) Water for life and livelihoods – River Basin Management Plan North West River Basin District</i>																					
<b>Water Resource and Quality</b>	<p>The River Calder runs through the Sellafield Licensed site. The River Calder catchment has an area of approximately 45 km<sup>2</sup>, and comprises predominantly agricultural or upland moorland. The River Calder runs for approximately 12 km from its headwaters in the fells to the coast. The New Mill Beck also runs through the site and the River Ehen flows adjacent to the site.</p> <p>The Sellafield site encompasses the Calder Hall and Windscale sites and as such their liquid discharges are assessed together. The sites' liquid radioactive discharges during 2011 included:</p> <table border="1" data-bbox="341 1212 1087 1448"> <thead> <tr> <th>Radionuclide or Group of Radionuclides</th> <th>Annual Discharge TBq</th> <th>Percentage of limit %</th> </tr> </thead> <tbody> <tr> <td>Total Alpha</td> <td>1.17E-01</td> <td>11.7</td> </tr> <tr> <td>Total Beta</td> <td>1.52E+01</td> <td>6.9</td> </tr> <tr> <td>Tritium</td> <td>2.07E+03</td> <td>10.4</td> </tr> <tr> <td>Carbon-14</td> <td>6.39E+00</td> <td>30.4</td> </tr> <tr> <td>Strontium-90</td> <td>1.93E+00</td> <td>4.0</td> </tr> <tr> <td>Cesium-137</td> <td>5.86E+00</td> <td>17.2</td> </tr> </tbody> </table> <p>The discharges were assessed to contribute to a combined dose (i.e. not just from the Sellafield site) to the critical group (a group or representative individual who receive the largest dose from artificially produced radionuclides due to their habits, diet and where they spend their time) during 2011 from environmental radioactivity of 0.23 mSv/y or 23% of the public dose limit.</p> <p>In 2011, some 6.07 million m<sup>3</sup> of water was abstracted from a number of sources. During this period the net amount of water used by the Sellafield site was 3.16 million m<sup>3</sup>.</p>	Radionuclide or Group of Radionuclides	Annual Discharge TBq	Percentage of limit %	Total Alpha	1.17E-01	11.7	Total Beta	1.52E+01	6.9	Tritium	2.07E+03	10.4	Carbon-14	6.39E+00	30.4	Strontium-90	1.93E+00	4.0	Cesium-137	5.86E+00	17.2	<i>NDA (2005) Sellafield EAPINS Project Questionnaire;  SL statutory returns provided under authorisation KP3690SX;  Environment agency et al. (2011) Radioactivity in Food and the Environment 2011;</i> <i>Non-Radiological Pollution Inventory (PI) Return for the 2011</i>
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<b>Waste</b>	<p><b>Sellafield Site</b></p> <p>On the 1<sup>st</sup> April 2012, at the Sellafield site there was estimated to be 1,780 m<sup>3</sup> of HLW, 74,900 m<sup>3</sup> of ILW and 4,030 m<sup>3</sup> of LLW in storage on the site which will be retrieved and temporarily stored until a national off site repository is established or until LLW is disposed of at the LLW Repository near Drigg as appropriate. The HLW is comprised of raw and conditioned wastes, the ILW is comprised of raw, interim stored and conditioned wastes and the LLW is entirely raw waste.</p>	<i>NDA (2011) 2010 UK Radioactive Waste Inventory; Sellafield Ltd NSP Returns 2012</i>																					

	<p>It is estimated that at the end of operations and decommissioning at Sellafield, there will be 1,260 m<sup>3</sup> of HLW, ~300,000 m<sup>3</sup> of ILW and ~570,000 m<sup>3</sup> of LLW (all packaged waste).</p> <p>In 2011 some 2,600 tonnes of non-hazardous waste was generated and 16% was reused or recycled. 116 tonnes of hazardous waste was generated in this period with 38% being reused or recycled. There was also 40 tonnes of inert waste generated in 2011, 0% of this was reused or recycled.</p>	
<b>Economy, Skills and Society</b>	<p>According to the 2010 mid-year estimate the total population of Copeland is 69,500.</p> <p>In recent years out-migration has been concentrated amongst the younger, economically active age groups, leaving high proportions of older people and the very young with resulting high service dependencies.</p> <p>In 2010-2011, 31,300 Copeland residents were in employment. Between 2010 and 2011 employment levels within the Borough increased by 4.8%.</p> <p>In 2010-2011 the number of pupils achieving 5 A*-C GCSEs was 77%. This was slightly higher than both the regional and national averages of 48% and 58%.</p> <p>Sellafield employs some 10,500 personnel and from 2005 to 2010 is estimated to have contributed £1,150 million to the economy.</p>	NDA (2011) <i>Sellafield Site Lifetime Plan 2011;</i>  Office of National Statistics <a href="http://www.neighbourhood.statistics.gov.uk/">http://www.neighbourhood.statistics.gov.uk/</a>
<b>Traffic and Transport</b>	<p>Vehicular access to Sellafield from the national highway network is by way of the A595 which runs from the outskirts of Workington to the north of the site to Dalton-in-Furness to the south. The roads connecting the operational site to the surrounding area are primarily single lane carriageways. The M6 motorway is located 50 miles to the east of the site and is the principal primary route running north-south.</p> <p>The Sustrans National Cycle Network route No. 72 from Egremont to Seascale railway stations passes alongside the Sellafield complex, past the Sellafield railway station.</p> <p>A local bus operator runs a private bus service to local destinations from the Sellafield complex.</p> <p>The nearest rail facilities for workers are the railway stations at Seascale and Sellafield. Services to Sellafield generally operate 9 to 10 times a day from most local stations.</p>	Sustrans website <a href="http://www.sustrans.org.uk">www.sustrans.org.uk</a> ;
<b>Land Use and Material Assets</b>	<p>The area of the nuclear-licensed site is 276 ha including the Calder Hall and Windscale nuclear sites. The site is also located to the north of the LLW Repository near Drigg. Approximately 2 km to the east is the Lake District National Park, which is used predominantly for agricultural and recreational uses. The settlement of Seascale is located to the south of the site.</p> <p>In 2011, the Sellafield site (including Calder Hall and Windscale) consumed some 411,000 MWh of energy and some 6.07 million m<sup>3</sup> of water. These figures compare to 380,000 MWh of energy use and 6.29 million m<sup>3</sup> of water use in 2010</p>	MAGIC website <a href="http://www.magic.defra.gov.uk">www.magic.defra.gov.uk</a> ;  NDA (2007) <i>Sellafield 2006/07 Lifetime Plan</i> ; Sellafield Ltd NSP Returns 2011 & 2012

<b>Noise and Vibration</b>	<p>In August 2005, an application was made to the EA under the Pollution Prevention and Control (England and Wales) Regulations 2000 for the Sellafield PPC Installation, part of this application was an assessment of noise and vibration. It should be noted that the Sellafield PPC Installation does not cover all operations on the site, but it does cover the majority and any noise surveys will have picked up the total noise from the site.</p> <p>Several noise surveys were carried out at a number of receptors located around the site perimeter for the PPC application. However, noise levels from the site were so low that for several of the locations, the noise readings were dominated by local sources such as farm animals, machinery or passing traffic. The noise surveys carried out for the PPC application indicated that the noise levels in the environment around the installation are unlikely to be a cause of public concern.</p> <p>An annual site noise report is produced based on two noise surveys carried out during the year. These reports have concluded that there has been no significant change in the noise levels from the site.</p> <p>A number of complaints have been received from members of the public because of sudden noise emitted from the site. These relate to steam releases from the Fellside Combined Heat and Power Plant which are caused by pressure safety relief mechanisms and other steam venting points during operation of the plant. The plant management are aware of the sensitivity of the issue and try to minimise local disturbance. Sellafield Ltd engaged with the local community following the complaints to provide an opportunity for dialogue and ensure that communication protocols were firmly established.</p> <p>No significant sources of vibration have been found within the installation that would produce perceptible effects at the selected receptor sites, therefore no vibration monitoring was carried out.</p>	Application for the Sellafield PPC Installation (BM4317), section B2.9 noise and vibration: Environmental Permit noise monitoring surveys for 2009 and 2010.
<b>Health and Safety</b>	<p>In 2011, the discharges to the atmosphere from Sellafield were assessed to result in doses to the critical group (a group or representative individual who receive the largest dose from artificially produced radionuclides due to their habits, diet and where they spend their time) of 0.010 mSv/y or approximately 1% of the public dose limit. The impacts of liquid discharges to the aquatic environment were assessed to give a combined dose of 0.23 mSv/y to the marine critical group, or 23% of the public dose limit.</p> <p>Buildings at Sellafield cover a spectrum from early 1950s plant to modern, well-designed plant. At some of the older plants, early standards of shielding and containment design, together with the build-up of historic contamination, contribute to relatively high background dose rates in parts of the Sellafield and adjacent Windscale and Calder Hall sites. In 2011, average employee and hired staff doses at Sellafield were 0.72 mSv/man yr and average contractor doses were 0.97 mSv/man yr.</p> <p>In 2011/12, Sellafield Site recorded 31 RIDDOR incidents compared to 26 RIDDOR incidents in 2010/11.</p>	Environment agency et al. (2011) <i>Radioactivity in Food and the Environment</i> 2011; Site Specific Data

## Future Developments

Discharges from Sellafield have reduced significantly from their historic peaks in the 1970's. Further significant reductions are anticipated when reprocessing is completed and as decommissioning progresses.

Discharges for Windscale and Calder Hall, already low compared to Sellafield, are likely to decline further due to the reduction in decommissioning activities when those sites enter care and maintenance. However, there may be short term increases in discharges corresponding to peaks in decommissioning activities such as the demolition of the reactors and other structures during final site clearance.

It is anticipated that decommissioning will result in a significant generation of radioactive waste volumes which will need to be conditioned and packaged. ILW and HLW will continue to be stored on site until a suitable national facility is able to receive waste.

## Environmental Issues

Adequate protection exists to protect the site from coastal flooding for the near future. Defences are currently maintained by Network Rail primarily to protect the railway line between the site and the Irish Sea. Should Network Rail cease the maintenance of defences, alternative mitigation measures may be required. If the UK Climate Impacts Programme (UKCIP) high emission climate change scenarios are realised, the effects of climate change and coastal erosion may make the southern area of the Sellafield Site vulnerable to flooding within the next 100 years unless defences are maintained. However, this is unlikely to have a significant impact on Windscale and Calder Hall.

The site overlies an aquifer in the underlying sandstone geology, which is known to be significantly contaminated in the southwest due to the leaching of contamination from the site.

On the Sellafield site, there is an estimated 1,600 m<sup>3</sup> of soil contaminated with radioactive material which is contaminated to Intermediate Level Waste (ILW) levels, as well as just over 1 million m<sup>3</sup> of soil contaminated to LLW levels. There is also estimated to be some 11.8 million m<sup>3</sup> of soil contaminated with radioactive material which will require management as High Volume Very Low Level Waste, and may be authorised for on site disposal.

Since 2006, the application of enhanced beach monitoring near Sellafield using the techniques developed for Dounreay has identified a number of contaminated finds on local beaches. These are more diverse and generally contain less active radionuclide material than those identified at Dounreay. Arrangements are in place to monitor for these items and recover those which are found.

