



**NATURAL
ENVIRONMENT
RESEARCH COUNCIL**

Delivery Plan 2005-2008

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Executive Summary

The Natural Environment Research Council (NERC) will contribute to the Government's 10-year Science and Innovation Investment Framework by ensuring the health of environmental research within the UK Science and Engineering Base and by supporting research that can be exploited to provide solutions, for the economy and society, to critical environmental challenges.

NERC funds independent world-class basic and strategic research and survey, needed to predict the changing environment and to create sustainability of natural resources, for the benefit of society and the economy. NERC's vision is that by innovative research directed at the grand challenges, such as prediction of the impacts of seasonal-to-decadal climate change, it will address the critical environmental challenges facing mankind.

This multidisciplinary "big" science needs flexible and strategic programmes in our centres, including the provision of long-term capability and national facilities for research. It also requires excellent university research, training of next generation scientists and career development. The research must be planned and implemented so that it delivers the required information, in a timely fashion, for policy and business use, and to engage society.

NERC will further pursue its goals set out in its strategy "Science for a Sustainable Future", with the following priorities for the SR2004 period:

- To improve predictions of climate change, globally and regionally, NERC will invest in research in atmospheric aerosols, ocean circulation and the Antarctic environment, where some of the greatest uncertainties lie. National and international partnerships in multidisciplinary research, such as in the International Polar Year, and policy areas, such as climate change, are critical to ensure NERC does world-class research in collaboration with world-class scientists.
- In environment and human health, partnerships with sister councils and other organisations will stimulate multidisciplinary research to enable management of the environment and hazard-risk to improve peoples' health. New research will enable more reliable risk-assessment of flooding that feed early-warning systems.
- Three-dimensional survey, characterisation and modelling of the UK's landmass and submarine systems will provide baseline geo-environmental information critical to socio-economic development of the environment.
- Knowledge transfer will become an integral part of carrying out NERC research including: forming partnerships to commercialise activity from its research centres; encouraging collaborative research and development; supporting co-operative training and education; developing science-into-policy activities; engaging the public and end-users when setting research priorities; ensuring that research outcomes make a difference.
- NERC will implement mechanisms to ensure the best training for future environmental scientists through enhanced PhD student support, early career development fellowships and, with other research councils, Academic Fellowships as a pathway to academic positions.
- To meet these scientific challenges, NERC will: construct the Antarctic base Halley VI and the research vessel James Cook; develop remote sensing technologies; and ensure UK access to key high-performance computing.

1 Introduction

This Delivery Plan sets out how NERC will use its resources for the Spending Review period (2005/06 to 2007/08) to contribute towards achieving the Government's Science Budget objectives, as set out in the Government's 10-year Science and Innovation Investment Framework¹ and the Office of Science and Innovation's (OSI) Science Budget strategy. During the period of this Delivery Plan, NERC will complete the delivery of "Science for a sustainable future", which is the first phase of addressing Earth system science. NERC will be also planning the next phase, building on the outcomes of the past five years, to deliver NERC's vision.

Successful implementation of this Delivery Plan will require collaboration between NERC research centres, collaborative centres, and universities, other funders and partners (e.g. government departments & agencies, charities, industry, regional development agencies and our sister research councils) within the UK, and a variety of partners within Europe, North America and elsewhere in the world.

Deliverables are identified in relevant sections of this plan. The Delivery Plan is complemented by: a scorecard to chart progress against objectives, and a cross-council outputs framework, which collates performance information. This information will be used in NERC's decision-making to allocate resources, inform future direction and to provide accountability to OSI.

Our plan

The Spending Review 2004 allocated NERC about £1 billion over three years to deliver its mission. This included additional resources to sustain the science base as part of dual support reform.

In addition to our ongoing prioritisation to provide agility in the research base to respond to priorities, NERC also undertook a reprioritisation exercise associated with SR2004. This has enabled investments to be directed to new interdisciplinary science priorities. About 3% of the NERC budget has been redirected, enabling these emerging priorities to be funded (Section 2).

Fundamental to NERC's approach is delivering environmental science for the benefit of society and the economy. An example is NERC's Proudman Oceanographic Laboratory, which working with the Department for Environment, Food and Rural Affairs (Defra), provides sea-level data and modelling support to the Storm Tide Forecasting Service at the Met Office. The Service tells the Environment Agency (EA) if there will be likelihood of flooding. The EA can then issue flood warnings, perhaps even closing the Thames barrier. What is the cost of getting it wrong? A major flood in London could cost £30 billion, without counting the loss of human lives. Our vision of how NERC science can inform business, policy-makers and contribute to the economy and society is provided in Section 3.

¹ Science and Innovation Investment Framework 2004 – 2014, July 2004, www.hm-treasury.gov.uk/spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm

OSI's Science Budget strategy identifies two broad outputs that will be delivered through the Science Budget in collaboration with other funders. This plan identifies how NERC will address these higher-level objectives through two main outputs:

Output One – A Healthy Science and Engineering Base

- **Strategic, interdisciplinary research** aimed at new priority areas and continuation of existing investments (Section 4).
- **Blue skies** (Section 5) and **cross-cutting science and technologies** (Section 6) that aim to maintain UK capability in environmental sciences, and how we will deliver our science (Section 7).
- Providing **highly skilled trained people** (Section 8) for academia and the UK economy, including the development of capability in emerging strategic areas such as environment and health.
- **International collaboration** (Section 9) stimulating the best scientific collaboration to increase knowledge and tackle global challenges.
- Providing **world-class facilities and infrastructure** (Section 10) and enabling UK scientists to access some of the best international facilities available.
- Pursuing our agenda on **science and society** to gain public confidence in science and building relationships with key stakeholders to improve coordination of environmental research in the UK (Section 11).

Output Two – Better Exploitation

- Establishing **knowledge transfer** as a key component of NERC's activities and intensifying our interactions with industry and in 'science to policy' (Section 12).

2 The Spending Review 2004 Settlement

As a result of the 2004 spending review NERC's budget will grow from £369.8 million in 2005/06 to £401.0 million in 2007/08.

	2005/06	2006/07	2007/08
Total Allocation² £ million	369.8	382.3	401.0
Including Capital³ £ million	31.3	35.4	40.1

The budget includes resources over the period towards:

improving the health and long-term sustainability of the university research base.

Research councils will be paying 80% of the Full Economic Costs of research in Higher Education Institutions for applications received from September 2005;

encouraging more attractive and effective research career pathways for our best researchers, through continued implementation of the 2002 Robert's Review recommendations; and

ensuring the long-term fitness-for-purpose and sustainability of research council institutes through additional capital funding, accompanied by a more strategic approach to capacity planning for Public Sector Research Establishments (PSREs).

Annex 1 provides a more detailed overview of NERC's financial information.

² Excluding end of year flexibility

³ Excluding capital grants

3 Delivering Environmental Science for the Benefit of Society and the Economy

The Earth's environment is in a state of change. NERC science helps drive the UK capability to predict these changes over a range of timescales, from hours to centuries. As the accuracy improves, environmental prediction will be used ever more frequently as a tool for economic advantage. Environmental prediction informs business, policy-makers and society of the future state of the environment and options for change to deliver sustainable solutions to environmental challenges.

Our capability to predict the environment is fundamental to protecting the health of our planet and our economic well-being. Through the atmosphere, oceans and land the environment provides the critical services to sustain mankind, for example water, food, fuel and medicines, with values that run into thousands of billions of pounds.

Our goals are challenging. We need to predict the impacts of climate change on regional and local scales so that we can provide meaningful advice on the optimum mitigation and adaptation strategies around the UK and in Europe. We need to be able to answer the questions *'How will UK's climate change? What different sea defences do we need in Scotland compared to Southern England?'* We need to seize the opportunity to work with business to develop the 'right' environmental technologies to place UK industry in a position to view climate change as a business opportunity. And beyond climate change, we need to deliver forecasts, which directly enhance people's lives – *'How will urban pollution affect the air we breathe today? and 'Is the house that I am thinking about buying at risk of subsidence?'* And in the longer term, we must improve our capability to provide advice on the risk of major geo-hazards, for example earthquakes and tsunamis.

How can NERC enable these goals to be met? Solving many of the most pressing environmental problems demands a fundamental understanding of the connectivity, across a vast range of time and space scales, between different components of the Earth. Not only the complex interactions between the natural-science realms of oceans, air, land and ice, but also the interface with human society, in its economic, social and political dimensions. Working in this way requires more than multi and interdisciplinarity; it demands new ways of working that break down intellectual, cultural and bureaucratic barriers. This is Earth system science (ESS).

The UK is a world leader in ESS modelling and climate change prediction. In many other areas the UK is second only to the USA, and closing the gap. Maintaining this leadership edge will require: innovative mechanisms enabling interdisciplinary work with skilled mathematicians, physicists, engineers and socio-economists; major national and international partnerships; high performance computing and data-handling facilities far in excess of those currently available; comprehensive, 'intelligent' Earth observation and monitoring systems; and world-class laboratories, satellites, ships, autonomous vehicles, aircraft and field sites.

Our Delivery Plan has two main outputs: a healthy UK science and engineering base and better exploitation of the research.

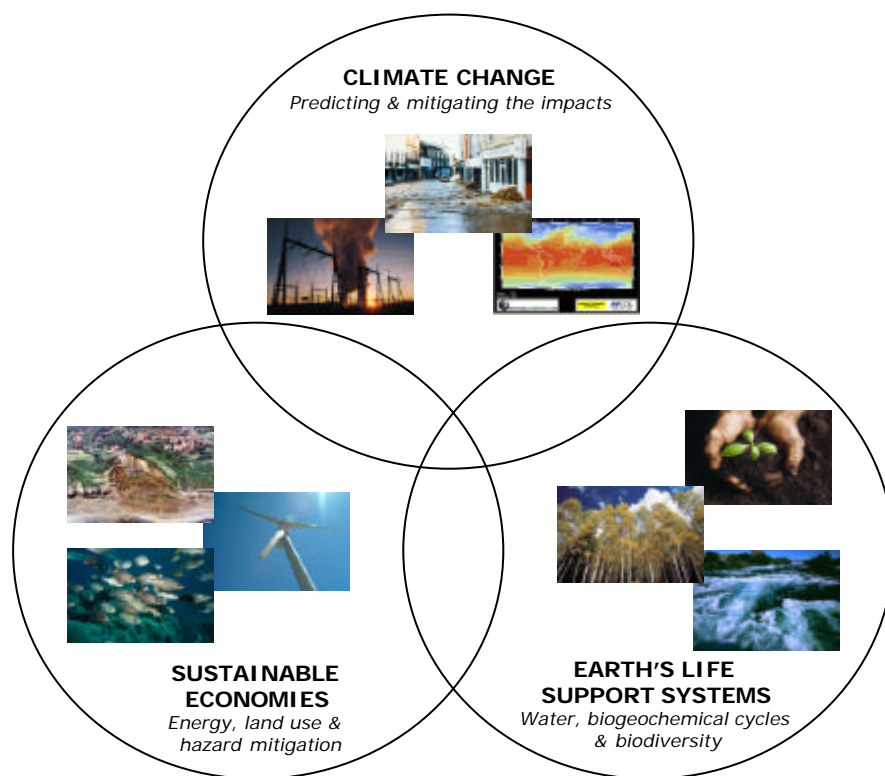
A HEALTHY UK SCIENCE & ENGINEERING BASE

4 Strategic Science

NERC's strategy 'Science for a sustainable future' identifies three strategic science priority areas, developed through extensive consultation with our community and stakeholders; climate change, Earth's life-support systems and sustainable economies. The strategy provides a framework for allocating resources, including investment in strategic and blue skies research, training, knowledge transfer, long-term environmental observation, research infrastructure and facilities.

The priorities in the following sections provide an overview of the science that NERC continues to deliver and identifies where some new investments will be made.

NERC's interdependent strategic science priorities



These priority areas serve as a pragmatic working categorisation, whilst noting that many areas of NERC's activities cut across these areas, given the nature of the multidisciplinary environmental challenges.

Climate change

Improved prediction of the various drivers of climate change, and consequent impacts, is needed to minimise and mitigate effects that will cause serious harm to the environment, the economy and society. The environmental sciences community, working with others, seeks to understand the integrated physical, chemical, geological and biological response to climate variability, and the consequent feedback on the climate system, at local, regional and global scales. Climate change science continues to be addressed through our portfolio of investments through universities and NERC centres.

During this Delivery Plan period, our priorities are:

- To significantly improve predictions of climate change, globally and regionally, NERC will invest in research in atmospheric aerosols and ocean circulation, where some of the greatest uncertainties lie.
- A major effort in addressing Antarctic processes that play key, but uncertain, roles in the Earth's climate system.
- To continue to improve understanding of large-scale processes and interactions in the Earth system, through our Quantifying and Understanding the Earth System (QUEST) programme, that will help our ability to find sustainable solutions to environmental problems.

The Intergovernmental Panel on Climate Change identifies atmospheric aerosols as one of the largest sources of uncertainty in quantifying and predicting global and regional climate change and its impacts. **Aerosols** affect climate through direct radiative effects (scattering and absorbing radiation), and indirect effects (e.g. controlling cloud properties). The challenge is to provide major advances in understanding the nature and life cycles of atmospheric aerosols, to enable substantial reductions in climate change uncertainties.

The UK is a world leader in atmospheric science and this challenge will be taken forward by NERC and the Met Office's Hadley Centre and through international partnerships in research and policy areas. New investments (£4 m during SR2004) will complement aerosol research in NERC's UK Surface-Ocean, Lower-Atmosphere Study (UKSOLAS), QUEST, Centre for Ecology and Hydrology (CEH) and NERC Centres for Atmospheric Science (NCAS) programmes, utilising the new state-of-the-art research aircraft facility.

The slowdown or collapse of the North Atlantic Ocean's overturning circulation is a 'low probability, high-risk' event that, in a globally warming world, could drive a cooling of Western Europe. NERC's **Rapid Climate Change (RAPID)** programme aims to better predict the likelihood and strength of such a rapid change in climate. A cornerstone of this effort is the design and establishment of a trans-Atlantic system to continuously observe the strength and structure of the overturning circulation. An additional investment will be made to develop the observing system beyond proof of concept, towards an international component of a long-term global climate observing system. NERC's links with the USA's National Science Foundation (NSF) and National Oceanic and Atmospheric Administration (NOAA) will be strengthened through the RAPID programme. Additional collaborative programmes with the Netherlands and Norway will be underway in 2005/2006.

The British Antarctic Survey (BAS) programme, **Global Science in the Antarctic Context** delivers integrated, interdisciplinary research, monitoring and survey primarily in the Antarctic and the surrounding Southern Ocean. It focuses on science areas where the Antarctic contribution will make a significant difference to understanding fundamental environmental science issues and the functioning of the Earth as a system, in close

partnership with other national and international programmes. As such, the programme delivers broadly across NERC's strategic priorities, but with seminal contributions in climate change science.

The **UK Surface-Ocean, Lower-Atmosphere Study (UKSOLAS) (£8.3 m during the SR2004 period)** programme will advance understanding of environmentally important interactions between the atmosphere and the ocean, through study of exchanges of material which affect ocean productivity, climate and atmospheric composition. Importantly it aims to identify what their influence is on the global climate system. UK SOLAS will influence and benefit from the International SOLAS programme.

Improved predictions of climate change from these and other investments will be enabled by explicitly creating linked hierarchies of models allowing researchers to intelligently apply combinations of models, and by increasing collaboration with the Hadley centre. Through NERC's ongoing **Quantifying and Understanding the Earth System (QUEST)** programme (£13.3 m over the SR2004 period), and harnessing E-science investments, these collaborative efforts will build towards the creation of next generation Earth system models.

As part of its overarching role, **QUEST** uses integrative, interdisciplinary approaches to provide increased knowledge of large-scale processes and interactions in the Earth system, especially the interactions among biological, physical and chemical processes in the atmosphere, ocean and land, and their implications for human activities. In so doing, QUEST will drive the solution of major outstanding problems in Earth system science.

Deliverables

Between 2005 and 2008 we will:

- generate new knowledge of the large-scale processes and interactions of the Earth system through understanding climate processes, required to advance predictive capability;
- evaluate the trans-Atlantic observing system for the North Atlantic overturning circulation; and
- provide new trained people in interdisciplinary research areas related to climate change.

We have:

- developed research capability to tackle aerosols, one of the biggest uncertainties in climate change.

Earth's life-support systems

Fundamental to supporting life on Earth is the cycling of water and natural and man-made chemicals through its systems. These provide the basis for supporting a rich variety of biodiversity and ecosystem services. However, natural and man-made environments provide numerous challenges to human health and well-being, and many of these challenges are increasing. Research outcomes will: inform better water-management systems; improve the quantification of the Earth's carbon cycle; and enable better management of the environment to reduce the risks to human health.

NERC's centre programmes make significant contributions to this area across terrestrial, freshwater, atmospheric and marine realms. These programmes will be complemented by other ongoing NERC investments, such as the Integrated Ocean Drilling Programme (IODP) and UKSOLAS, with the QUEST programme increasingly integrating the Earth system dimension of the community, including the carbon-cycle elements.

During this Delivery Plan period, our priorities are:

- To increasingly enable the management of the environment and hazard-risk in a way that improves peoples' health.
- To enable more reliable risk-assessment of flooding on timescales of minutes to decades, and short-term flood forecasts that feed early-warning systems.
- To continue to develop NERC's science in the areas of biodiversity, water and soils management and deep oceans.

Both natural and man-made environments provide numerous challenges to human health and well-being, and many of these challenges are increasing. Moreover, social and economic factors mean that different segments of society are differentially affected. The growing importance of the **environment and human-health** issue is reflected in UK and international priorities, for instance in the Environment Research Funders' Forum, the EU, the World Health Organisation, and International Year of Planet Earth 2006. The fundamental question is 'How do we manage the natural and built environment to improve human health?'

Partnerships with sister councils and others, such as the Wellcome Trust and the Environment Agency, will play a critical role in the bringing together of environmental, epidemiological, social and medical researchers to build capability. During SR2004 NERC will invest £2.4 m. We will also continue to explore additional collaborations with the Department of Health, Defra, the Department for International Development (DfID), the Scottish Executive Environment and Rural Affairs Department (SEERAD) and the Food Standards Agency (FSA).

Flooding is a costly environmental hazard with annual damage from floods of around £1bn in the UK at present levels of protection. There is evidence that more frequent flooding resulting from increases in the frequency and intensity of storms may be a consequence of anthropogenic climate change. Improved ability to forecast, quantify and manage flood risks, and mitigate effects of climate variability and change, is therefore essential to maintaining a sustainable economy.

The **Flood Risk from Extreme Events (FREE)** programme (£4 m during SR2004) enables NERC to extend the fundamental understanding of the physical processes that contribute to flood risk in the UK by investigating precipitation, river catchments, groundwater and coastal

flooding processes. This includes flood forecasting and warning over time-ranges from minutes to weeks and quantification of long-term flood risk over periods extending from seasons to several decades.

Continuing research in **biodiversity** is aimed at: improving the molecular science base for genetic diversity and function; measuring biodiversity; understanding and predicting the functioning of ecological systems, from populations to ecosystems; the effects of biodiversity change on the sustainability of ecosystems, landscapes, and livelihoods; and defining what strategies should be employed to mitigate those effects.

Biodiversity activities include: a unique controlled environment facility (Ecotron) that enables experiments to be performed on entire model communities, the Global Population Dynamics Database brings the largest collection of animal and plant population data together in the world, ongoing activities in environmental genomics provide data that tests evolutionary and ecological theories to inform our understanding of ecosystem function. Biodiversity is integrated into several other themes including; sustainable marine bioresources, and environment and human health.

The **deep ocean** is the largest single habitat for life on our planet and yet it is the least well studied. The deep ocean plays a major, but poorly quantified, role in moderating the Earth system as a whole, due to its capacity for bulk carbon storage and buffering of greenhouse gases. Through co-ordinated investments in new NERC centre programmes, linked to RAPID, QUEST and consortium grants, UK scientists will be positioned at the forefront of deep ocean research, with the support of outstanding technology (e.g. remotely operated deep-sea robot; Autosub; new NERC research ship *RRS James Cook*). Strong opportunities exist for: advances in biotechnology; new sensors; deep-sea environmental impact assessment. Significant advances will require strong international partnerships, notably with the USA.

NERC will investigate how to increasingly integrate **water and soils research**, cutting across centre investments and beyond.

Deliverables

Between 2005 and 2008 we will:

- invest in activities to predict and mitigate flood risk.

We have:

- built an interdisciplinary community to address challenges in environment and human health;
- generated new knowledge in the areas of water management, biodiversity and ecosystems to enable better stewardship of the environment; and
- positioned UK scientists at the forefront of deep-ocean research to explore its role in moderating the Earth system as a whole, through co-ordinated investment by NERC Centre new programmes.

Sustainable economies

A priority for the UK is using land, natural resources and energy sustainably whilst ensuring economic growth for the nation. Priorities will be aimed at identifying and providing sustainable solutions to the challenges associated with issues such as; land use, hazard mitigation, marine bioresources and energy.

During this Delivery Plan period, our priorities are:

- Working with stakeholders, to use new NERC centre programmes to help build a platform for delivering science critical to the sustainability of marine bioresources.
- To build on cross-council investments and partnerships in energy, in particular, deliver science in the areas of renewable energy and carbon dioxide (CO₂) sequestration.
- Three-dimensional survey, characterisation and modelling of the UK's landmass and submarine systems, which will provide baseline geoenvironmental information critical to social and economic development of the environment.
- To continue working with sister councils to deliver the objectives of the Rural Economy and Land Use (RELU) programme.

A combination of climate change and human activities (e.g. fishing, dredging, oil/gas, tourism, bioprospecting) is driving dramatic widespread changes in the marine environment. There is growing recognition that fundamental understanding of the functioning of today's living marine environment, its sustainability, and its susceptibility to change, demands a much more innovative research effort than simply managing fish-stocks.

NERC, in close collaboration with Defra, SEERAD, and other funders, agencies and industry, will identify the critical areas of interdisciplinary research that need to be tackled to enable significantly more effective **sustainable management of marine bioresources**. New programmes in NERC centres, building on the outcomes of NERC's Marine Productivity directed programme, will provide a focus for NERC working in partnership to deliver the critical research and its transfer to policy realms.

The ambitious target set by the Government is to reduce the UK's carbon dioxide emissions to 60 percent of 1990 levels by 2050. The challenge is to find reliable, diverse, affordable, publicly acceptable and safe ways to supply and use **energy**, including energy efficiency.

Over the next 5 years NERC research, in partnership with others, continues to build on the strong base provided by the cross-council funded Tyndall Centre for Climate Change Research, the newly established UK Energy Research Centre, and other SR2002 investments (Towards a Sustainable Energy Economy programme), and use strengths in NERC research and collaborative centres to focus on areas such as:

- Research to underpin the identification and development of viable renewable sources of energy, for example biofuels, tidal, offshore wind.
- Carbon dioxide sequestration research to assess the potential for the capture/storage of CO₂ in geological formations and through land-use change.
- Managing indigenous UK oil and gas supplies.

The new British Geological Survey (BGS) strategic science programme themes that will provide **three-dimensional survey, characterisation and modelling of the UK's landmass and submarine systems**. The programme will provide baseline geoenvironmental information critical to social and economic development of the

environment, including: the sustainable use of natural resources; protection of the environment in offshore and coastal areas; and the top few hundreds of metres of land – where most human interaction takes place.

NERC continues to work in partnership with ESRC, BBSRC and government departments to deliver the programme on **Rural Economy and Land Use** (RELU). This programme aims to enhance and expand capabilities for integrative, interdisciplinary and policy-relevant research on rural issues e.g. integrated land and water use, sustainability in the food chain and of alternative land use practices.

Deliverables

Between 2005 and 2008 we will:

- publish a NERC stakeholder analysis on science required for sustainable marine bioresources and to shape the new NERC centre programmes; and
- generate new knowledge in science to support economic sustainability including areas such as, natural resources, energy and land use.

We have:

- with other research councils in the energy programme, supported research in the areas of carbon management and renewable energy sources.

5 Blue Skies – Responsive Funding

NERC invests in a broad spectrum of research that is the bedrock of new discovery and invention and also helps to maintain the health of environmental disciplines. Blue skies funding is vital to support excellent ideas emerging from our science community. Currently NERC invests around £40 m per year in blue skies and consortium grants.

During this Delivery Plan period, our priority will be:

- To strengthen the UK environmental science base through enhanced investment in large interdisciplinary consortia and through blue skies grants.

During SR2004 NERC intends to invest more in the **blue skies** schemes to help maintain the amount of research supported. This will help to maintain the health and sustainability of the environmental disciplines.

NERC encourages “**consortium bidding**”, both under directed programmes and under a blue-skies grant scheme. An additional £4 m will be allocated by NERC to these schemes during SR2004. Consortia are expected to comprise several academic groups, normally from different disciplines and institutions, working in partnership with stakeholders and users to design and deliver a collaborative programme of world-class research. As part of the growth proposed in the consortium scheme, NERC will consider increasing its strategic emphasis.

Deliverables

Between 2005 and 2008 we have:

- increased investment in blue skies schemes to help maintain the amount of research and to support the health of environmental disciplines;
- increased the number of interdisciplinary consortia grants to strengthen the UK environmental base; and
- evaluated blue skies investments to identify broad science outcomes.

6 Cross-cutting Science and Technologies

Cross-cutting science and technologies provide a diverse range of capabilities, skills and tools that underpin and enable NERC's strategic science. They include, for example, Earth Observation, e-science, genomics, ocean coring, and NERC's contribution to the International Polar Year.

NERC's centres provide a national capability in long-term survey, monitoring and data management activities. Their roles include the development of observational systems, modelling and novel methods to manage, integrate and distribute data from diverse sources to advance knowledge of the Earth system.

During this Delivery Plan period, our priorities are to:

- Continue participation in the Integrated Ocean Drilling program within broadly defined themes of relevance to NERC strategy.
- Invest in the strategic area of polar science through the International Polar Year.
- Define the future priorities and investments in the European Space Agency (ESA).
- Develop a NERC technology strategy.

NERC's investment in the **Integrated Ocean Drilling program (IODP)** (£10 m over the SR2004 period) enables continued participation in, and steering of, the ocean research drilling, within the broadly defined themes of characterising the deep biosphere, process-understanding of past environmental change, and understanding solid-Earth dynamics. As a result of a recent drilling expedition led by the European consortium within IODP, in which NERC is a key partner, NERC scientists will acquire high resolution records of climate change since the peak of the last ice age that are of sufficiently high temporal resolution, accuracy and dating to resolve critical questions of the mechanisms of environmental change over the past 25,000 years.

The **International Polar Year** 2007/08 will be an intense, internationally co-ordinated programme of research and observations that will initiate a new era in polar science. The programme aims to: determine the environmental status of the polar regions; deepen our understanding of polar processes and their global linkages; increase our ability to detect changes; develop the next generation of polar scientists and engineers; and provides an opportunity to capture the interest of the public and decision-makers. This initiative is supported by 18 leading polar nations including Australia, Canada, China, Iceland, Japan, Korea, Russia and the USA and will produce a leap in our understanding of the role of polar regions in global change.

BAS will host the International Programme Office and make world-class scientific contributions through the BAS programme, Global Science in the Antarctic Context. NERC will also invest £5m in a programme focused on Arctic science, delivered through large interdisciplinary consortium grants, as well as encouraging polar science through existing blue-skies schemes.

Satellite-borne instruments play a crucial role in obtaining accurate, continuous, synoptic and simultaneous measurements of the Earth's system. NERC is the lead UK agency responsible for developing new techniques for exploiting **Earth observation** data, new satellite instrumentation, and training Earth observation specialists, and will have a central role to play in the next decade.

In early 2006, NERC, in consultation with our partners in the British National Space Centre, will decide about the level of its future investments in ESA. These investments will cover a multi-year period straddling future spending review periods.

The NERC Earth Observation Centres of Excellence programme aims to maximise the exploitation of Earth Observation data across NERC science. NERC's Earth Observation Centres of Excellence and their communities will work with international scientists to maximise use of data from current satellite missions, and design instruments for future missions. To underpin NERC's science priorities we will investigate the establishment, with the Department of Trade and Industry (DTI), of a centre for Earth Observation Instrumentation.

NERC's science community has considerable experience of developing, modifying and adapting **technologies** to support its science requirements, for example in a range of environmental sensors. NERC recognises the need to engage in technology development as an integral part of scientific research, and the potential for a high level of spinout and joint developments with commercial and policy users. Recent examples include joint instrument development programmes with DTI, and further partnership discussions are underway through the Environment Research Funders Forum (ERFF). NERC is also engaged in the Environment Industries Action Group (co-sponsored by DTI and Defra).

NERC is developing a technology strategy focussing on establishing technology priorities to support NERC's science objectives.

For previous Spending Review cross-council programmes:

- NERC is ramping down 'ring fenced' investments in **E-science** and **genomics** science to make way for emerging priorities in multidisciplinary research. These two areas are being integrated into NERC activities. In addition, NERC is continuing to fund; infrastructural support for an environmental genomics data centre, and contribute to a cross-council 'core' programme for e-science.
- NERC will continue to work through the existing cross-council **Basic Technology** programme to seek opportunities for technology development of relevance to the environmental sciences community.

Deliverables

Between 2005 and 2008 we will:

- maintain capabilities and skills in a diverse range of underpinning cross-cutting science and technologies to enable NERC's strategic science; and
- with partners in the British National Space Centre, contribute and respond to the House of Commons S&T Select Committee Inquiry into UK Space Policy.

We have:

- with partners, decided on the level of future investment in the European Space Agency;
- published and implemented the NERC technology strategy; and
- made major advances in polar knowledge and understanding, including the development of a new generation of polar scientists and engineers.

7 How we Deliver our Science

NERC is both a funder and provider of scientific research, training, data, information, advice, facilities and equipment. NERC employs 2600 staff, owns four research centres, is a partner in 15 collaborative centres, invests in 70 universities, supports work in 16 academic analogues and supports about 1400 students (PhDs and Masters) at any one time.

NERC's strategy and Delivery Plan reflect the various ways we deliver our remit. The main delivery mechanisms are: responsive mode grants to universities and staff in NERC centres; core support for four major wholly-owned centres; contracts to collaborative centres, primarily (but not exclusively) in partnerships with universities; directed programmes in which funding is won competitively, specialist services and facilities to support the whole community; and major infrastructure (including ships, aeroplanes, Antarctic bases, and satellites).

NERC may draw on combinations of these delivery mechanisms, in a way that best enables a given objective to be met. The delivery mechanisms have different purposes. Responsive mode provides support for 'blue-skies' ideas that arise from the community. Centres (Annex 2) provide national, strategic science capability, including long-term survey and monitoring, curation of invaluable datasets, and strong knowledge transfer to a variety of end-users or are set up to tackle specific science challenges. Directed programmes are time-limited, and address defined areas of NERC science through competitive grants.

To deliver our services effectively and meet the modernising Government agenda we need to understand the requirements and aspirations of our scientific and user communities, and offer excellent service and value for money.

Activities for NERC during the SR2004 period include:

- Greater efficiency, which covers two main areas, the Research Councils UK (RCUK) admin convergence and identifying and implementing Gershon efficiency savings.
- Governance - including responding to the modernising Government agenda, Freedom of Information, and Environmental Information regulations.
- Renewing strategic programmes in NERC centres with increasing emphasis on direct delivery of NERC strategic aims and infrastructural sustainability.
- Continuing to develop NERC's performance management framework.
- Development and publication of the next NERC strategy (2006/07).
- Greening NERC by setting highest possible standards for our environmental performance and leading environmental management in the UK public sector.

Deliverables

Between 2005 and 2008 we will:

- work with other councils to deliver the RCUK efficiency savings of an annual total of £170 m by 07/08;
- review and renew strategic programmes in NERC centres;
- establish NERC's long-term strategic priorities and strategic framework for delivering the priorities; and
- work with other councils to set up the Shared Service Centre.

8 Trained People

NERC trains and develops skilled individuals to meet national needs, spending around £29 m a year on training activities. This includes support for around 350 new PhD's per year, 325 masters students, and 30 new Fellowships per year.

During SR2004, OSI will provide additional funds to support PhD candidates for an average of 3.5 years. Our PhD training programmes will enable flexibility in provision, support for interdisciplinary research projects, and opportunities for transferable and technical skills training. Support for outreach activities such as Researchers in Residence, and employer focussed training will continue over the SR2004 period. NERC monitors progress in its training provision to respond to emerging issues and opportunities.

Future investments in training will be informed by a recently completed extensive review of our training portfolio. The following areas will be taken forward:

- Continue early-career support for top environmental scientists through fellowships, and investigate opportunities for further support in interdisciplinary areas.
- Undertake a zero-based review of MSc provision, putting greater emphasis on user/employer involvement and meeting UK skills needs.
- Address the need for more researchers with quantitative skills, through support for PhD students and through support for masters level conversion courses.
- Ensure people are trained to meet emerging interdisciplinary challenges, for example, energy research and environment and human health.
- Continue to offer enhanced stipends in subject areas where recruitment is difficult, and investigate alternative ways to attract the best candidates.
- Regularly review the need for funding more studentships to underpin the Government and European target of spending 3% of GDP on R&D by 2010.
- Remain responsive to the European agenda for increased mobility of researchers.
- Continue support for schemes at the policy, regulatory and business interface and enforce that a minimum of 30% of NERC studentships will be CASE Awards.
- Remove barriers and encourage participation in research by under-represented groups such as women returners and ethnic minorities, for example through continued support of the Daphne Jackson Trust Fellowship Scheme.
- Continue providing a more attractive and stable career path into academia through the New Investigators and Academic Fellowship schemes.

Deliverables

Between 2005 and 2008 we will:

- continue to invest in trained people and target some of this training to meet interdisciplinary challenges.

We have:

- delivered a review of Masters' provision that helps to address users and employers needs in the UK.

9 International Collaboration

Global environmental change, especially climate change - and our dependency on natural resources and energy - threaten sustainable development. These threats are not constrained by or governable within, national borders. Solutions to global challenges require knowledge that only the very best cooperative scientific effort can deliver.

NERC continues to foster international collaboration, to ensure: greater impact and higher-quality science; stimulation of technological development and innovation, shared access to facilities, data and knowledge; science advocacy; and the promotion of excellence through international comparison. These activities contribute to enhanced economic growth and alleviation of poverty. At least 40% of NERC funded outputs are delivered in collaboration with overseas scientists.

The UK already has a strong track record in hosting, and participating in, international environmental science initiatives involving world-class researchers. In particular NERC collaborates internationally in the following: EU Framework programmes five, six and seven, the International Drilling Program (IODP), European Space Agency's Earth observation science programmes; International Polar Year and others. Specific international activities include:

International Opportunities Fund - this fund will stimulate and enable high-profile/high impact international activities within its programme areas.
NERC provides international scientific leadership, influence and partnership within International programmes, notably the World Climate Research Programme (WCRP) and the International Geosphere Biosphere Programme (IGBP) . These major programmes operate under the auspices of the International Council for Science, Intergovernmental Oceanographic Commission, the World Meteorological Organisation, and other intergovernmental bodies.
NERC funds and manages several International Project Offices (IPOs) : WCRP's Climate Variability (CLIVAR) project; IGBP's Global Ocean Ecosystem Dynamics (GLOBEC); Global Environmental Change & Food Systems (GECAFS), and Surface-Ocean Lower-Atmosphere (SOLAS) projects; DIVERSITAS – biosustainability; International Polar Year.
Earth simulator – UK-Japan collaboration. NERC, Hadley Centre and Japanese scientists continue to develop a world-beating scientific and technical partnership in global climate modelling using the Japanese Earth Simulator.
Developing UK –China relationships. Recognising the growth and opening up of China's science base, NERC is exploring the potential for strategic collaboration in the areas of climate change, polar science and geological approaches to carbon capture.

Deliverables

Between 2005 and 2008 we will:

- work with the International Group of Funding Agencies (IGFA) to review the funding arrangements of IPOs to improve their long-term sustainability; and
- develop closer co-operation with DfID.

We have:

- established NERC's International Opportunities Fund to stimulate UK leadership in programme areas; and
- delivered collaborative workshops and explore potential for strategic collaboration with China and the FCO as part of UK/China Partners in Science Initiative.

10 Facilities and Infrastructure

Large facilities

To enable NERC to deliver its scientific remit on a global scale we will continue to facilitate access for UK scientists to large facilities owned by international partners, including marine barter arrangements, the Japan Earth Simulator and the ESA programme.

NERC is contributing to an emerging European agenda. The European Science Forum for Research Infrastructures (ESFRI) is preparing a European Roadmap for Large-scale Infrastructures, which will be used by the Commission to inform pump-priming funding decisions in Framework Seven.

Large facilities by their very nature have long planning and commissioning periods. During the period covered by this plan, NERC will work on the following projects to replace current NERC owned and operated facilities:

- Deliver the RRS James Cook, by August 2007, in accordance with agreed contract
- Begin construction of the Halley VI Antarctic Research Base in January 2008. Planned to begin operating in 2008/09 (total cost £38 million).
- Consider the case for the construction of a research vessel to replace the RRS Discovery.

NERC, Hadley Centre and Japanese scientists continue to build the foundations for a world-beating partnership in global climate modelling. The experience gained on the Earth Simulator is laying the groundwork for the effective procurement and utilisation of the next generation UK high-performance computing service.

Infrastructure in universities and dual support reform towards financial sustainability of university research

NERC is working with OSI and other research councils to move towards funding research on the basis of a percentage of full economic costs. This work will ensure that by September 2005, all the research councils are able to process applications and provide funding on this new basis.

Infrastructure in research centres

NERC is committed to ensuring that it invests sufficient capital in our own research centres to ensure that they remain internationally competitive, with appropriate equipment and buildings. To achieve this, we are investing at least £20 m per annum (in addition to NERC contributions to non-building related large facilities) in buildings and equipment. This investment will be managed in line with NERC's Capital Investment Strategy to ensure that it is effectively prioritised and managed and in line with the JM Consulting recommendations undertaken for OSI. Such an investment, averaging over £24 m per annum in total will protect and develop NERC's infrastructure into the long term.

Deliverables

Between 2005 and 2008 we will:

- begin the replacement process for the RRS Discovery;
- begin the Construction of the Halley VI Antarctic Research Station and remove Halley V.
- work with councils and other partners to procure next generations high-performance computing capability; and
- ensure that research centres infrastructure is put on a sustainable trajectory in line with the NERC Capital Investment Strategy.

We have:

- completed the construction of the RRS James Cook; and
- implemented 80% full economic costing for universities.

11 Stakeholder Engagement

The research councils are committed to delivering their separate and joint (Research Councils UK) strategies on **science and society**. NERC's policy on science and society continues to focus on accountability combined with engagement and dialogue with the public. We have a balanced portfolio covering three main areas: consultation on science areas ahead of their final adoption; communication of the results of our research; and debates and consultations on topical issues around our science.

Increasingly activities are being organised with other research councils, and will be incorporated into the RCUK science and society strategy. Issues we will address include:

- Public confidence in science – through an RCUK consultation with the public in 2005/06.
- Public engagement activities to help define the content and priorities of joint research programmes.
- Engagement of stakeholders, users and the public in how research is conducted and how the outcomes are used.
- Engaging young people in science, through continuing our joint activities in CREST and Researchers in Residence, and improving teachers' knowledge of topical issues through funding science-learning centres.
- Encouraging our scientists to engage with the public about science. RCUK and the Royal Society will repeat a survey to gauge scientists' attitudes to science.
- Informing the public about science achievements by increasing our output of media releases and briefing materials, and through events such as 'Science Week'.
- Working with others to promote public engagement (E.g. RCUK debate on climate change at the Euroscience Open Forum. Plans for another activity in Munich 2006).

NERC continues to develop and build relations with key **stakeholders** to identify and set priorities and deliver key strategic activities as follows:

- Work through the **Environment Research Funders' Forum** (ERFF) to develop a vision for, and improve coordination of environmental research in the UK.
- Engage in open consultation on emerging science priorities and in developing NERC's next strategy (publish in 2007).
- Increase user engagement in the development and delivery of science programmes, to transfer knowledge to users at the earliest opportunity.
- Increase 'affiliate' membership of the peer review college to gain greater involvement of end users in the peer review process, and to expand its role to other NERC schemes.
- Continue regular high-level meetings with government departments and agencies, Parliament, NGOs, charities and other organisations.

Deliverables

Between 2005 and 2008 we will:

- improve user engagement in the development and delivery of science priorities; and
- increase public consultation of science issues.

We have:

- through ERFF, increased the coordination of environmental sciences in the UK; and
- redeveloped the NERC web site to improve user and public access to NERC science.

BETTER EXPLOITATION

12 Knowledge Transfer

Creating the Environment for Knowledge Transfer

This section sets out the purpose and objectives for NERC's contribution to Knowledge Transfer, together with examples which illustrate NERC's impact in this area. Information on the approach taken to support future activities is also provided, together with a concluding section summarising deliverables. An additional £6 m will be devoted to new KT initiatives over SR2004.

1) **NERC's environment for Knowledge Transfer**

The Natural Environment Research Council delivers independent research, survey, training and knowledge transfer in the environmental sciences, to advance knowledge of planet Earth as a complex, interacting system.

The expected economic expansion and population growth of the developing world, combined with current trajectories for developed nations, are driving increasing pressures on natural resources and global climate. These resources, and the ecosystem services they provide (such as building minerals, fuel, forestry, food, water supply, good air quality, biodiversity, leisure) are critical to economic security and quality of human life.

Working with partners, we will provide the knowledge that will enable successful policy, technology, and business solutions to the challenges posed to prosperity, natural resource sustainability and health of the environment. NERC has a particular role in developing predictions of the future state of the environment, providing a critical evidence-base for decision makers.

2) **Purpose and objectives of NERC KT**

NERC aims to maximise the impact of its funded research on the economic, social and environmental well being of the UK, through active knowledge transfer. In line with the Baker and DTI Innovation Report Recommendations NERC integrates knowledge transfer into its scientific management and planning at all stages.

In particular, NERC will:

- a) Ensure policy makers have access to the highest quality environmental information and predictions, in order that the UK can deliver economic prosperity and sustain a healthy environment.
- b) Provide funding, skills and networks by which environmental science can be transformed into commercially valuable enterprises .NERC will also actively seek opportunities to exploit intellectual property (IP) and know-how in wider markets.
- c) Provide direct services and products through exploitation of data, knowledge, skills, assets and manpower in its research centres and supported university groups. On many occasions such activity will encompass collaborative

research with industry and public sector bodies which not only creates economic value but also leverages extra benefit from core science budget funding.

- d) Develop and train skilled individuals, and foster excellent research environments which both respond to the UK skills needs and attract other world leading scientists into the UK.

3) Sphere of Influence

NERC-funded science generates know-how and IP that is of value in a wide range of markets including biomedical, oil and gas, and agriculture. However, a key market is that for Environmental Goods and Services (valued by the DTI at £25 billion in the UK alone). This market is predominantly legislation driven. In the UK, it is underdeveloped, dominated by SMEs and characterised by low levels of R&D. These characteristics have tended to discourage university technology transfer offices from actively engaging in this area (preferring medical / engineering projects), and has also discouraged venture capitalists.

Therefore NERC must influence and respond to the activities of Government Departments and Regulators, not only to influence policy per se but also to thereby influence industry and the economy. It must also play a more proactive role in ideas management at HEIs, from generation, development, proof of concept, and through to access to first stage funding.

4) Segmented Approach

NERC employs a number of mechanisms tailored to respond to its KT objectives. These are summarised in the table below, with more detailed examples provided on pages 4-12.

	Impact through policy	Commercialisation	Products and services	Skills transfer
Key mechanisms Employed	<ul style="list-style-type: none"> ▪ Basic research ▪ Directed Programmes ▪ Commissioned Research 	<ul style="list-style-type: none"> ▪ NERC Innovation Fund ▪ Follow-on Fund ▪ Business Plan Competition 	<ul style="list-style-type: none"> ▪ Commissioned Research ▪ Data products and services ▪ Partnership Research Grants 	<ul style="list-style-type: none"> ▪ Facilitators ▪ CASE PhD studentships ▪ Knowledge Transfer Partnerships

5) Organisation

NERC has constituted a Board consisting of the Director of Science and Innovation, the Director of Finance and key KT managers, to direct its Knowledge Transfer programme delivery against Output 2. This reflects the high priority given to KT within NERC, and also the wish to integrate KT into our mainstream business. Two specialist delivery streams report to this Board:

- a. A team focussed on harvesting and developing NERC-owned IP. The team here have skills relating to business development, IP protection, licensing and

venture capital management. Key support is provided by a ground breaking, risk reward based partnership with Isis Innovations, and a key interface is with the Rainbow seed fund, of which NERC was a founder member.

This section is led by the Director of Finance, and supported by a cross research centre advisory group.

Research Centres strategic funding bids have to clearly state KT goals and plans. Day-to-day operations of the KT / commercial portfolio then rest with the centre Director, with an overview kept at NERC level.

- b. A team working closely with science programmes, generating IP not owned by NERC. This team has skills in working with University academics, funding and programme planning. By working with scientific programme managers and steering committees, they are able to ensure that KT is considered from the inception of a NERC directed programme. They also organise responsive proof of concept and development funding for academics who are unable to access funds through their own university technology transfer offices. A linked science-into-policy team manages the provision of advice to policymakers, through, for example, NERC inputs to consultations and parliamentary inquiries, targeted briefings and identifying key policymakers to engage in relevant NERC activities.

This area is led by the Director of Science and Innovation, and is supported by an external consultative panel.

A number of activities underpin both streams and are thus managed on an integrated basis. In particular liaison with RDAs, industry relations / networks, and market analysis

The next sections of this document provides examples of NERC’s impact for each of its KT objectives, some information on the approach taken to support future activities, and a concluding section summarising deliverables.

A. Impact through policy

NERC-funded research makes a substantial contribution to policy development, monitoring and assessment. Commissioned research in our Research and Collaborative Centres plays a particularly important role, in that the Centres provide a national capability to provide reliable and independent policy advice to Government, thereby playing a crucial role in evidence-based policy making.

Highlights of policy impacts include:

There’s a hole in my ozone layer

British Antarctic Survey (BAS) scientists discovered the hole in the ozone layer in 1985. Their discovery, based on robust and long term data, led to a major realisation and international acknowledgement that human activity was having a significant and negative impact on the global environment. They provided a crucial part of the argument for a ban on chlorofluorocarbons (CFCs) and gave impetus to the implementation of the Montreal Protocol on Substances that Deplete the Ozone Layer.

The Discovery of the hole in the ozone layer and subsequent research has the potential of helping to achieve wider benefits for the UK economy by helping to reduce the number of skin cancer cases in the UK. It has been projected that in the absence of the Montreal protocol, the cost of skin cancer for the UK would provide a present value saving well in excess of £100m.



Daily ozone-sonde launched from the BAS Halley base

Capturing emissions

The Statoil Sleipner project was the world's first demonstration of carbon dioxide capture and underground storage. It is of great interest to the international community because if the concept can be applied to power stations it holds out the promise of making deep cuts in global CO₂ emissions - without having to abandon fossil fuels.

The British Geological Survey (BGS) is among the organizations involved in monitoring and modelling the distribution of injected CO₂ in the Utsira Sand to check that it is behaving as predicted and is not migrating out of the intended storage site. This type of demonstration will do much to satisfy future legal verification requirements and allay public concerns about safety issues.

BGS was one of the main contributors to the formulation and publication of the UK's strategy for CO₂ Capture & Storage (CCS), launched by the Energy and Environment ministers (DTI & DEFRA) June 2005 "A strategy for developing carbon abatement technologies for Fossil Fuel use".

UK lead on GM Crop evaluation

Centre for Ecology and Hydrology (CEH) scientists and partners completed the biggest experiment of its kind in the world, designed to test the effects of growing Genetically Modified herbicide tolerant crops on biodiversity. The findings of this research are shaping Government policy in the UK and in Europe on decisions over commercialisation of a number of crops, and ensuring that other stakeholders, including UK industry are well informed.

Scientific evidence of this kind is essential, particularly given the contentious nature of the debate on Genetically Modified Organisms (GMOs). Whilst many people point to the benefits GMOs may bring to medicine, agriculture and pest control, others see GMOs as threats to the environment and human health.



Inspecting GM spring oilseed rape

NERC will continue to emphasise the key role it has in influencing the evidence based policy framework. In many cases, these drive the commercialisation, products and services, and training opportunities cited in the coming sections of this document. Key areas of interest will include Climate Change, Energy (nuclear, renewables, carbon storage) and the Water Framework Directive. Examples of the steps taken to support policy development are:

- Increasing policy-maker engagement in the development and delivery of science via the NERC Peer Review College and directed programmes;
- Appointing a new science to policy facilitator to promote the use of NERC science;
- Developing ways of synthesising the outputs of 'blue skies' research to make them more accessible to policymakers and other users;

B. Commercialisation

Intellectual property arising from NERC-funded research underpins services and products which contribute to many business sectors. In many cases the business opportunities arising from this science are best exploited by the private sector. The direct commercialisation of science through licensing and spinouts attracts private sector investment and avoids the constraints of exploitation within the public sector.

Examples are given below:

Innovative pharmaceuticals

NERC's first spinout 'Evolutec' came out of our Centre for Ecology and Hydrology and is based on the exploitation of the pharmaceutical properties of proteins found in tick saliva. The proteins offer the prospect of improved treatment of immune diseases such as asthma and rhinitis. Furthermore one of the proteins shows promise as an anti-tick vaccine that can prevent the transmission of tick borne diseases such as Borrelia. The company is continuing to gather strength. In 2004 it was floated on AIM and in November 2005 it raised a further £10M on this equity market. The markets for some of these target areas are worth several Billion dollars per year. The research leading to this success has produced a whole range of candidate therapeutic proteins and team are continuing to discover further compounds.



African brown ear tick

Greater efficiency in road maintenance

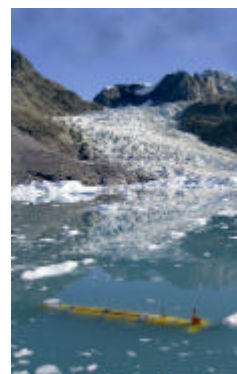
Entice Technology Ltd was spun-out from the University of Birmingham in 2002. It provides services to help the road maintenance industry make weather related decisions such as when to apply salt and grit. The technology helps local authorities save millions on unnecessary road salting. The company has recently expanded its operations to help the rail industry deal with icing problems. The science behind this innovation came out of NERC's URGENT programme. This programme has generated many other exciting prospects for commercialisation such as the assessment and treatment of brownfield land.

Valuable compounds from the oceans

NERC's recent science programme on 'Marine and Freshwater Microbial Biodiversity' has led to the discovery of a whole range of new microbes, many of which appear to produce compounds with innovative applications. One microbe in particular has been shown to produce a protein with activity against MRSA, an organism causing severe infection problems in many of our hospitals. Other prospects include ways of prevent biofouling and products for industrial processes.

Supporting the UK's offshore oil and gas industry

Autosub is a world-leading autonomous underwater vehicle that was developed at the National Oceanography Centre, Southampton. A 10-year licensing deal has been signed that enables this vehicle to operate in the oil, gas and sub-sea cable markets. The multi-million pound licensing deal was the biggest ever signed by the University of Southampton. The vehicle was awarded Millennium Project Status by the UK design council and has been displayed at the science museum.



Autosub in operation

Commercialisation of science in NERC owned research establishments

The IP produced in NERC's own research establishments is commercialised by NERC's own Commercialisation Team. Targets for key outputs are agreed with NERC research establishments and performance against these is reviewed on an annual basis. Targets include metrics for: the number of new ideas generated; the number of new projects initiated; the number of awards from the NERC Innovation Fund, the number of patents filed, and the number of deals completed.

Commercialisation of NERC funded science in universities and NERC collaborative centres

The primary responsibility for exploiting NERC funded science in Universities and collaborative centres rests with the host organisation. However, Council has recognised the value of supporting particular initiatives, particularly those in partnership with other research councils, where these can usefully supplement the activities of universities. Examples include the Research Council Business Plan Competition and the NERC/EPSRC/BBSRC Follow-on-Fund.

NERC will continue to emphasize the commercialisation of science. Examples of steps taken to support this are:

- The introduction of a ground-breaking partnership between NERC's Commercial team and Isis Innovation (the technology transfer arm of the University of Oxford) which enables NERC to gain access to the skills, expertise and networks established by this leading technology transfer office.
- NERC introduced its own business plan competition in 2000 and took the lead in establishing this initiative across all research councils and opening it to academics at all UK universities.

C. Products and services provided by NERC

The NERC funding of its centres and of university groups, generates the capability (in terms of people, skills and facilities) to directly contribute to the economy through the provision of goods and services, or to react quickly and effectively to avoid economic disruption. Some examples are:

Keeping London in business

Flooding caused by tidal surges is a serious threat to the people and businesses in London. The erection of the Thames barrier is a great engineering feat to counter this threat, however, this technology would be ineffective without NERC tidal data and prediction capabilities that inform decisions on when to raise or lower the gates. The cost of getting this wrong would be £30 billion, without counting the potential loss of human lives.



Thames Barrier

In addition, the Thames Barrier will reach the end of its design life in 2030 and the planning for its replacement has already started, led by the Environment Agency (EA). A critical decision is how much higher to build the new barrier to cope with rising sea level. The two greatest uncertainties are the frequency of storm surges and the contribution of the melting of Antarctica. BAS scientists are providing advice to the EA on the latter, and carrying out new research that will contribute to improved predictions of sea level rise.

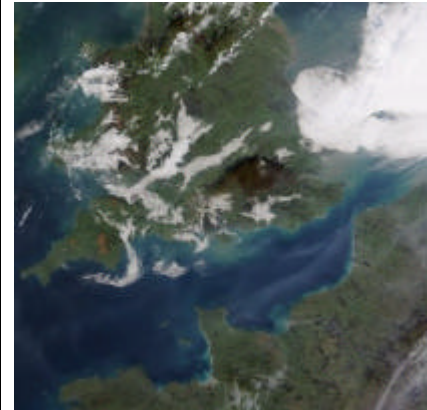
NERC has also contributed considerably to limiting flood damage elsewhere, both through information to guide the effective construction of coastal and river flood defences, and through improved flood modelling of river systems. The CEH produced "Flood Estimation Handbook" was a major step forward in this field of prediction.

Is it safe to build here?

There is currently a pressing need for increased housing capacity in Britain (particularly in the South East). It is crucial that housing and new industrial developments are made in suitable locations – otherwise costly remedial action and disruption may follow. We have already noted NERC's key role in identifying flood hazards, which enables flood risk to be evaluated at post code level, but certain dangers lie below ground. BGS offer a service called 'GeoSure' that provides information to developers, householders or local government, on potential ground movement or subsidence to determine the stability (and value) of land, property, and the safety of its occupiers. BGS is looking to extend this service further, in collaboration with the Coal Board, in order to provide a complete hazard risk assessment to the householder (including radon risk and risk from old mine shafts). We estimate that these BGS products have avoided potential losses in the insurance sector of at least £100m in the last decade - indeed this is a very conservative estimate and could be an order of magnitude below the actual level.

Don't Panic!

In response to a natural or man made disaster, economic disruption can be enormously costly. This can be made worse by over reaction based on lack of knowledge of the threat posed. The recent oil depot fire at Hemel Hempstead was the largest explosion in Europe since World War II. It released a huge dense smoke plume that caused widespread concern to residents and businesses in nearby areas. NERC was able to limit potential disruption in two ways: First the NERC /Met Office BAe146 research aircraft was scrambled to sample the clouds composition, and rapidly concluded it to be of relatively low toxicity: Secondly NERC satellite tracking facilities based at Dundee University was able to track and predict the course of the cloud to clearly identify areas likely to be affected. In this way potential mass evacuation and disruption was avoided.



Satellite imagery of smoke from oil depot

Oil Prospecting

Much of Britain's economic prosperity over the last 30 years has derived from North Sea oil and gas. It is essential that Britain is able to identify all possible exploitable hydrocarbon resources, and to extract them as efficiently as possible. The Ocean Margins LINK programme (2002 – 2006) provides vital information for industry. The science furthers understanding of the continental shelf, its structures and the processes that control change on geological time and a day-to-day basis. The UK together with Ireland shares an ocean margin over 1500 km in length containing valuable oil and gas reserves but the economic benefits of this huge area have not yet been fully determined.

Specifically, the Ocean Margins LINK programme contributes to the following industry "challenges":

- Improved prediction in exploration and reservoir characterisation, on the UK margin and globally;
- Gas hydrates as a hazard and potential energy source;
- Prediction of deepwater geohazards (e.g. slope failures); and
- Sustainable management of hydrocarbon resources in the deep-water environment.

One notable partnership outside the oil and gas sector is the telecommunications industry that has co-funded work to predict where undersea cables should be routed to avoid underwater landslides and other hazards.

NERC will continue to emphasise the key role it has in supporting the development of products and services based on NERC funded research. Examples of the steps taken to support this are:

- Introduction of a Partnership Research Grant scheme which aims to promote collaborative research activities between academic researchers and partners in public or private sector organisations. The scheme will be implemented through a recently awarded LINK franchise.
- Ensuring a sustainable mix of contract work and science budget work is undertaken at its research centres, while controlling risks and liabilities
- Targeting the increased access to, and use of its valuable data holdings by UK householders and industry.

D. Training and Skills transfer

Training the next generation of scientists is a fundamental component of NERC's programme. This ensures that the UK maintains its position at the forefront of environmental science research, supplies skills to the UK workforce to sustain our economy and provide centres of excellence that attract the best researchers to the UK.

Highlights of our training investments include:

NERC Scientists ... the next generation

NERC supports both PhD studentships, and Masters courses, which both contribute strongly to UK skills needs.

NERC supports up to 350 CASE (Co-operative Awards in Sciences of the Environment) PhD studentships at any one time. These aim to promote partnerships between University and Industry (or public sector) bodies. CASE projects enhance the training received by students who will gain first-hand experience of work outside the purely academic environment. The CASE partners similarly benefit from closer access to academic research. Over 120 organisations currently collaborate directly in NERC-supported PhD training

NERC supported Masters courses are considered by employers as providing essential training responding to their needs. At present, NERC supports about 290 studentships per annum on around 50 masters courses.



Calibrating instrumentation

Seismic Hazard Assessment – Skills Transfer

Staff at NERC's Centre for Observation and Modelling of Earthquakes and Tectonics (COMET) are training young scientists from the Geological Survey of Iran in a range of techniques that underpin seismic hazard assessment. Iran has suffered a number of major Earthquakes in recent years, including the Bam earthquake which killed in excess of 50000 people in 2003. The Iranian scientists trained in this programme will play a leading role in the huge effort of assessing seismic hazard in Iran and, consequently, in its mitigation.

Knowledge Transfer in the Developing World

The British Geological Survey conducts a broad range of training and institutional strengthening programmes worldwide. At the present time, BGS has active programmes in: Afghanistan; Ethiopia; Ghana; Madagascar; Mali; Montserrat; Mozambique; Niger; Nigeria; Papua New Guinea; Saudi Arabia and the United Arab Emirates.

BGS also carries out some of these training and development programmes in partnership with industry. As an example, Fugro Airborne Services subcontracts all its training obligations in Africa to BGS. The current value of BGS overseas operations is about £10 million per year, of which the training and institutional strengthening components represent about £3 million per year.



BGS helping develop the geoscientific skills and knowledge infrastructure of Mozambique, as a pre-requisite to inward investment and economic development

Could the Atlantic current switch off?

The Rapid Climate Change Programme (RAPID) is expected to make a fundamental contribution to understanding and quantifying the likelihood and magnitude of rapid climate change in the near future in Western Europe.

The RAPID programme is the first major joint programme between the National Science Foundation in the US and NERC, also includes partners from Norway and the Netherlands. It has led to over £10m of international co-funding, and an independent review has judged that this programme is not only helping the Government to meet its stated aspirations to be global leader on issues such as climate change, but it is bringing other countries with it in the quest to understand the issues.



Deploying the RAPID instrument array

NERC will continue to emphasise the key role it has in training and skills transfer. Examples of the steps taken to support this are:

- Expanding our CASE annual competition to include public sector partners, in recognition of the important role that NERC science plays in public good and policy development.;
- Sponsoring the Royal Society Industry Fellowship scheme, to encourage the two-way flow of people between the research community and industry;
- Undertaking a zero-based review of NERC support for Masters courses. There will be considerable user involvement in the process, with user relevance an assessment criterion and user membership on the review panels.

Deliverables

Between 2005 and 2008 we will:

- improve the policy relevance of its science, and through improved communication, increase the impact of that science on policy formation;
- provide valuable services to the private and public sector, in the UK and internationally in balance with its core science activity;
- improve the performance of UK plc through greater access to its data holdings (while maintaining compliance with HMT fees and charges regulations)
- directly drive UK plc performance through delivery of a sustained increase in the rate of licensing and spinouts from NERC research centres;
- increase the promotion of commercialisation of NERC-funded science in universities and NERC collaborative centres;
- stimulate Knowledge Transfer in the UK environmental sciences by providing a source of advice and best practice for innovations in this area;
- make Knowledge Transfer a part of initial scientific planning for all NERC research investments;
- improve awareness of the impacts of NERC science; and
- begin implementation of the Warry report recommendations.

We have:

- implemented a LINK franchise to encourage more collaborative research across the NERC remit; and
- increased the numbers of environmental scientists and users with direct experience of working together on research programmes.

Financial Commentary

In 2006/07 NERC is projecting less than a 2% variance on the approved Science Budget.

This would have been below 1% but for the impact from the re-negotiation of the contract for the National Oceanographic Centre in Southampton, which added more than £2m to the overall budget variance.

This amount will be re-invested in Marine Science over the next few years.

In 2007/08 the cumulative end of year flexibility (EYF) is expected to exceed the NERC reserves target. However, as NERC plans under a flat-cash assumption for CSR07, the EYF balance is required to address significant funding pressures in 2008/09 and 2009/10.

On resource, directed programme activity commissioned in the 2004 spending review period is expected to accelerate, and significant restructuring costs will be incurred in creating the Research Councils' Shared Services Centre and the ongoing CEH transition and integration project. As a consequence the resource EYF balance will be fully utilised early in the Comprehensive Spending Review 2007 period.

On capital, the EYF balance will be fully utilised in 2008/09 as NERC commissions the construction of a replacement for the Discovery research vessel, and manages a short-term deficit in capital funding.

Table 1 provides a detail breakdown of Science Budget expenditure by activity. Table 2 summarises total resource income, and Table 3 itemises the main changes in Science Budget funding during SR04.

Table 1: Statement of Financial Requirement⁴

Priority	05/06 £'000		06/07 £'000				07/08 £'000	
	final outturn		resource		capital		plan	
	resource	capital	plan	draft outturn	plan	draft outturn	Resource @	capital @
<i>Strategic Science</i>								
Climate Change	32,234	148	36,768	33,395	1,158	419	38,218	2,797
Earth Life Support								
Systems	16,117	213	18,415	16,697	580	210	19,109	1,398
Sustainable								
Economies	5,372	46	5,890	5,566	185	70	6,370	466
Blue Skies ^	37,685	-	38,128	36,171	2,378	1,970	42,084	2,000
Cross Cutting Science and Technologies	103,592	30,332	114,108	108,167	31,068	33,460	107,467	26,928
Trained People ^	24,402	-	28,658	25,758	-	-	29,324	-
Facilities and Infrastructure *	68,922	1,118	51,386	52,471	11,677	13,098	55,894	13,825
Knowledge Transfer	6,049	-	7,680	6,675	-	-	8,111	-
Science and Society	1,690	-	1,640	1,762	-	-	1,753	-
Restructuring %				5,958	-	-	10,170	1,100
Non-cash #	45,313	-	29,573	25,244	-	-	20,154	-
TOTAL PLANNED EXPENDITURE	341,377	31,858	332,246	317,864	47,046	49,610	338,654	48,514
Science Budget	351,446	31,846	332,248	322,864	49,565	52,510	346,263	54,765
Outturn	10,069	(12)	2	5,000	2,519	2,054	7,609	6,251
EYF brought forward	7,210	2,066	30,104	17,279	2,231		14,507	5,805
Reduction to EYF +				(12,245)			900	(2,750)
Other EYF Adjustments				4,473		851		
Cumulative End Year Flexibility carried forward *	17,279	2,054	30,106	14,507	4,750	5,805	23,016	9,306

⁴ NERC has a target to retain a reserve comprising £5m resource and £3.5m capital

@ 07/08 Plan updated to reflect draft outturn for 06/07

^ Increase in expenditure over the SR2004 period is largely due to the introduction of full economic costing and an increase in consortium grant funding

* The reduction between 05/06 and 06/07 is due to a government led change in the treatment of capital grants (resource in 05/06 and capital 06/07) and the agreed funding profile on the European Space Agency subscription (weighted towards the CSR07 period)

% Includes the CEH transition and integration project, NERC corporate restructuring and mariners pension schemes

Includes depreciation on NERC assets, cost of capital charges and known future liabilities (provisions)

+ Includes £9.7m deduction by DTI and £2.545m retrospective deletion of EU DEL

Table 2: Resource budget and planned expenditure

£m

	2005/06	2006/07		2007/08
	final outturn	plan	draft outturn	plan
Science Budget	351.446	332.248	322.864	346.263
End of Year Flexibility	7.210	30.104	17.279	14.507
Reduction to EYF			(12.245)	
Virement to capital			4.473	
External Income	54.274	48.965	53.930	51.644
Total Resource available	412.930	411.317	386.301	413.314
Expenditure				
<i>Science Budget Expenditure:</i>				
Research	296.831	291.960	290.655	309.024
Training	24.402	28.658	25.758	29.324
Knowledge Transfer	6.049	7.680	6.675	8.111
Science in Society	1.690	1.640	1.762	1.753
Non-cash	45.313	29.573	25.244	20.154
Administration costs	21.366	21.700	21.700	21.932
Total Expenditure	395.651	381.211	371.794	390.298
Overall result against budget	17.279	30.106	14.507	23.016

Table 3: Total income

£m

Income	2005/06	2006/07		2007/08
	final outturn	plan	draft outturn	plan
<u>Science Budget</u>				
Near-cash	292.060	308.840	299.856	324.455
Non-cash	44.608	23.408	23.008	21.808
Capital Grants	14.778	14.678	13.369	14.678
Capital	31.346	35.387	39.641	40.087
<i>includes the following elements:-</i>				
<u>SR2004 Additions</u>				
<i>Resource</i>				
<i>Full Economic Cost</i>		17.318	14.742	19.621
<i>Roberts Review</i>		0.821	0.821	0.821
<i>Research Council Pension Scheme</i>	8.099	8.099	8.099	8.099
<i>Capital</i>				
<i>Research Council Infrastructure Fund</i>		2.181	2.181	4.361
<u>Large Facilities Roadmap Funding</u>				
<i>James Cook Research Vessel</i>	8.750	8.550	8.550	1.250
<i>Halley 6 Antarctic Base</i>	3.020	5.080	5.080	9.900
<i>Keyworth Blocks A-F</i>				5.000
<u>Other Additions</u>				
<i>Exchange Rate Compensation #</i>	5.369	3.684	3.169	3.222
<i>CEH Restructuring</i>		4.300	2.700	11.500
<i>Knowledge Transfer fund</i>		0.980	0.980	0.980
<i>Minor baseline adjustments</i>	0.398	0.573	0.573	0.573
<u>Deductions</u>				
<i>EU DEL</i>			-3.653	-3.653
<i>OSI near-cash overcommitment</i>			-1.100	-1.000
Science Budget	382.792	382.313	375.874	401.028
Loan from other Research Councils	0.500	-0.500	-0.500	
External Income	54.274	48.965	53.930	51.644
Total Income (excl EYF)	437.566	430.778	429.304	452.672
End of Year Flexibility	9.276	32.335	24.657	18.462
DTI reduction to EYF			-12.245	
Total Income	446.842	463.113	441.716	471.134

NERC CENTRES

1. NERC's four wholly-owned **research centres**:
 - British Antarctic Survey,
 - British Geological Survey
 - Centre for Ecology and Hydrology
 - Proudman Oceanographic Laboratory

2. NERC **collaborative centres** funded by contract:
 - NERC Centres for Atmospheric Science (NCAS)
 - Plymouth Marine Laboratory (PML)
 - The Scottish Association for Marine Science (SAMS)
 - Sea Mammal Research Unit (SMRU)
 - National Oceanography Centre, Southampton (NOC, Soton)
 - Centre for Population Biology (CPB)
 - Earth Observation Centres of Excellence
 - Centre for Observation and Modelling of Earthquakes and Tectonics (COMET)
 - Centre of Observation of Air-Sea Interactions and Fluxes (CASIX)
 - Centre for Polar Observation and Modelling (CPOM)
 - Centre for Terrestrial Carbon Dynamics (CTCD)
 - Climate and Land Surface Systems Interaction Centre (CLASSIC)
 - Data Assimilation Research Centre (DARC)
 - Environmental Systems Science Centre (ESSC)
 - Tyndall Centre for Climate Change Research
 - National Institute for Environmental eScience (NIEeS)

LIST OF PROGRAMMES AND ACRONYMS

Short Name	Programme Description
FREE	Flood Risk from Extreme Events aims to understand the physical processes that contribute to flood risk in the UK
IODP	Integrated Ocean Drilling programme enables research drilling in ice-covered regions or in shallow waters
IPY	International Polar Year
QUEST	Quantifying and Understanding the Earth's System aims to provide improved understanding of large-scale processes and interactions in the Earth system
RAPID	Rapid Climate Change aims to predict the likelihood and strength of rapid changes in climate
RELU	Rural Economy and Land Use science will be used to inform rural issues e.g. integrated land and water use
SOLAS	Surface-ocean, lower atmosphere study aims at the understanding of environmentally important interactions between the atmosphere and the ocean.
TSEC	Towards a sustainable energy economy programme
UKERC	UK Energy Research Centre

Other acronyms	
EA	Environment Agency
ERFF	Environment Research Funders' Forum
ESA	European Space Agency
FSA	Food Standards Agency
KT	Knowledge Transfer
NSF	National Science Foundation (USA)
PSA	Public Service Agreement
RDA	Regional Development Agency
SEERAD	Scottish Executive Environment & Rural Affairs Department
SEPA	Scottish Environmental Protection Agency
SISB	Science and Innovation Strategy Board