

4. Working in Partnership

Work to value and conserve geodiversity in Norfolk is being co-ordinated by the Norfolk Geodiversity Partnership (NGP). The NGP developed in 2007 from a geoconservation group, the Norfolk RIGS Committee. It is a voluntary association of organisations and individuals who are committed to conserving and enhancing Norfolk's special Earth heritage, and acts as an umbrella group to promote geoconservation in the county. It is developing relationships with a wide range of organisations and individuals, for example museums, land owners and managers, government agencies and quarry companies.

In 2008 Natural England offered the NGP funding to develop a Geodiversity Action Plan (GAP) for Norfolk. GAPs provide a new comprehensive approach to conserving Earth heritage, setting out a management framework for geology, geomorphology, soils and water resources for a defined area or an organisation. GAPs are modelled on the successful Biodiversity Action Plan format for managing the conservation of species and habitats in Britain. Since 2004 a range of Local GAPs have been prepared in the UK, covering various Areas of Outstanding Natural Beauty, counties, metropolitan areas and national parks. There are aggregate company GAPs, and a national UKGAP is currently at an advanced drafting stage.

A Norfolk Geodiversity Action Plan (NGAP) has been prepared to accompany this book. It aims to bring about a qualitative change in the way that Norfolk's Earth heritage is conserved and communicated. You are invited to contribute actively to the realisation of the Plan; maybe you are already doing so.

Action for geodiversity

A wide range of individuals and organisations are involved with conserving and promoting Norfolk's geodiversity, either directly or indirectly. Action is happening in various ways across the county, as part of daily life and business. For example:

- river restoration work;
- maintaining museum displays relating to Earth heritage;
- conserving landform features as part of farm Environmental Stewardship;
- lectures, field trips and evening classes on the county's Earth heritage;
- landowners permitting access to geological features for study and fossil collecting;
- monitoring condition of SSSIs, also Local Sites for NI197;
- maintaining historic environment records;



Removal of embanking along the river Glaven at Hunworth 2009, to help restore the river's connection with its floodplain.

Photo © River Glaven Conservation Group



Aldeby gravel pit is now disused and landscaped. However a conservation section has been retained as part of site after-use planning by Norfolk County Council, 2008.

Photo © Jenny Gladstone

- developing the Norfolk Biodiversity Action Plan, particularly as it relates to habitats;
- conserving geodiversity features in wildlife reserves such as County Wildlife Sites;
- outdoor interpretive panels explaining the links between geodiversity and biodiversity;
- publishing information about landscape and environmental history;
- surveying and mapping geological and geomorphological features;
- incorporating geodiversity conservation into Local Development Framework documents;
- educational work at Field Centres;
- including geoconservation objectives into after-use plans at mineral extraction sites;
- amateur and academic research into Norfolk's geology, environment and archaeology including specimen collecting;
- local activities related to Geo-East's 'Chalk East' project;
- protecting soils and groundwater through the Catchment Sensitive Farming initiative.

These actions are links in a network of official and unofficial activity helping to promote the aims of the Norfolk Geodiversity Action Plan.



Photo © Martin Warren

A Cromer Museum guided walk 2008 to see geological features at West Runton cliffs, including the Cromer Forest-bed.



Photo © BGS@NERC.

An interpretation panel is being installed by the British Geological Survey at Wiveton Downs explaining the origins and significance of the Blakeney Esker.

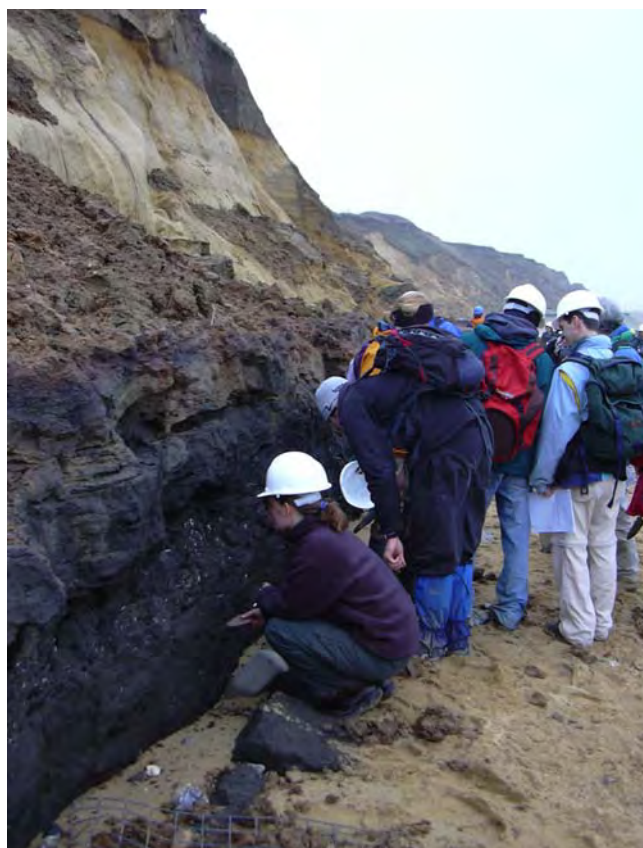


Photo © Dr Kim Cohen, Department of Geography, University of Cambridge

Communicating geology: university students studying the sediments of the West Runton Freshwater Bed.

The Norfolk Geodiversity Action Plan

The NGAP presents a set of objectives, actions, lead agents and timescales for the current period. Other actions may be introduced as resources allow, for example if taken up by partners. The NGAP has five work areas:

Work Area 1 – Understanding our geodiversity resources

Norfolk's geodiversity comprises cultural as well as natural resources. We need to understand these resources and their vulnerabilities in order to promote their conservation and enhancement.

This work involves carrying out an audit of the county's geodiversity, using published sources and personal communications to build a list of significant sites and features in the field, and also cultural resources such as museum collections. The next step is to verify and assess this information by means of a ground-truthing programme.

Work Area 2 – Embedding geodiversity in plans and policies

The plans and policies of local and regional government and other organisations such as quarry companies have an impact on the geodiversity resource. We need to promote geodiversity conservation and enhancement by reviewing and contributing to these plans and policies.

This work involves responding in detail to public consultations, and may involve recommending policy formulations. Geodiversity information outreach may be a supporting aspect of this work.

Work Area 3 – Protecting and enhancing our geodiversity resources

Norfolk's geodiversity resources are subject to a range of threats, and even statutorily protected sites and features may be at risk. We need a conservation and enhancement programme both for designated sites and for geodiversity in the wider environment.

This work involves using the results of the geodiversity audit and a schedule of geoconservation priorities to identify candidate sites and features for Local Sites designation. These sites may then be designated and Site Management Plans agreed with their owners/managers to gain positive conservation management.

Other work includes monitoring the condition of designated sites, recording temporary geological sections, and developing practical resources for geoconservation such as volunteer labour. It may be necessary to explore new approaches to protecting geodiversity assets in the wider environment away from designated sites.

Work Area 4 - Promoting geodiversity awareness and understanding

One of the greatest threats to Norfolk's geodiversity is a lack of understanding of its importance as a fundamental resource. We need to promote public awareness of our Earth heritage as widely as possible.

This work involves publishing information about Norfolk's geodiversity, the Action Plan and other initiatives for geodiversity. It includes educational work and tourism focused on Norfolk's Earth heritage, and also contributes to regional action for geodiversity.

Work Area 5 – Managing the Norfolk Geodiversity Action Plan

The sustainability and success of the Norfolk GAP will depend on the strength and commitment of the Partnership. We will need to develop the Partnership as a key means of sustaining the GAP process.

This work involves managing and enhancing the Partnership and taking forward the NGAP, for which developing funding resources may be necessary. It will involve contributing to regional and national geoconservation initiatives.

An invitation

We invite you to join the Norfolk Geodiversity Partnership, and support the development and implementation of the Action Plan.

We also invite you to share information about your / your organisation's activities and achievements for Norfolk's geodiversity. This can be published through a Norfolk Geodiversity Partnership newsletter and website. Please contact:

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Appendix 1 - Information resources

1) Geodiversity in Norfolk

- Background
- Specialist sources
- Soils
- Water
- The Palaeolithic
- Landscape character
- Designated sites and areas

2) General geodiversity

3) Geoconservation

- General geoconservation
- Geoconservation in planning
- Geoconservation and biodiversity
- Geoconservation and the minerals industry

4) Geodiversity in education

5) Geodiversity in Museums

6) Geodiversity groups

Please notify the Norfolk Geodiversity Partnership if you know of any resources which you think should be included in this list. The hyperlinks were correct in August 2010.

1) Geodiversity in Norfolk

Background

From the early 19th century onwards, many hundreds of books and scientific papers have been written about the geology and landforms of Norfolk. Unfortunately, there is little introductory material on Norfolk geodiversity written for the general reader.

'Nature in Norfolk. A Heritage in Trust' (Jarrold & Sons, Norwich; 1976) has several excellent essays on Earth heritage and links between geodiversity and habitat.

'An Historical Atlas of Norfolk' by P Wade-Martins (ed) (Norfolk Museums Service; 1994) contains short chapters on the physical character of the county and early human settlement.

'British Regional Geology: East Anglia and Adjoining Areas' by CP Chatwin (HMSO 1961) - a useful short guide to the region, although the 'Superficial Deposits' and 'Early Man' sections need urgent revision.

The Norfolk Museums and Archaeology Service website has introductory pages on Norfolk geology, including the West Runton Elephant and information sheet downloads, and also a bibliography of N Norfolk geology and a Field Guide to NE Norfolk by Martin Warren. See

<http://museums.norfolk.gov.uk/default.asp?Document=400.500>.

The Natural England website has an excellent summary of Norfolk geology. See http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/englands/counties/area_ID24.aspx.

'A Flora of Norfolk' by G Beckett and A Bull (Gillian Beckett; 1999) contains fine introductory chapters covering the influence of geology and soils on landscape, species, habitats and landuse history.

'The Land-use, Ecology and Conservation of Broadland' by M George (Packard, Chichester; 1992) provides unparalleled detail about the geology, physical and human geography of the Broads, including water, soils and natural history.

'Geology of northeast Norfolk: Hunstanton to Happisburgh' by J Eyers (Rocks Afoot Field Guide Series; 1998) (see <http://www.rocksafout.com/>).

Introductory books on the evolution of the landscape include:

- 'England's Landscape: East Anglia' by T Williamson (Collins; 2006;)
- 'Southern England: The Geology and Scenery of Lowland England' by P Friend (Collins New Naturalist Library; 2009.)

[Specialist sources](#)

The British Geological Survey online publications catalogue, including Sheet Memoirs and maps for most parts of the region and some of Norfolk. See <http://www.bgs.ac.uk/catalogue/home.html>. See also the old 19th century Memoirs of the Geological Survey of Great Britain which cover most districts in the county. For online information about rock units and stratigraphic terminology, including a concordance of old and new terms, see the BGS Lexicon of Named Rock Units at <http://www.bgs.ac.uk/lexicon/>.

'The Geology of Norfolk' by GP Larwood and BM Funnell (eds) (Transactions of the Norfolk and Norwich Naturalists' Society Vol.19, pt.6; 1961) is a valuable collection of papers (re-edited in 1970), although the information about glacial deposits now needs substantial revision.

The Geological Society of Norfolk publishes an annual Bulletin of specialist articles on various aspects of East Anglia geology and geomorphology. See <http://www.norfolkgeology.co.uk/>.

The Quaternary Research Association regularly conducts specialist field trips in Norfolk, and publishes associated scientific papers in its annual Field Guides. Editions relevant to Norfolk include

- 'Pliocene-Middle Pleistocene of East Anglia' (1988)
- 'Central East Anglia and the Fen Basin' (1991)
- 'The Quaternary of Northern East Anglia' (2000)
- 'The Quaternary Mammals of Southern and Eastern England' (2004)
- 'The Quaternary of Norfolk and Suffolk' (2008)

See <http://qra.org.uk/>.

The complexities of the Pleistocene of Norfolk are subject to lively, ongoing debate. Readers looking for an introduction to this challenging period, for which Norfolk is famous, could do worse than begin with 'Pleistocene Environments of the British Isles' by RL Jones and DH Keen (Chapman and Hall 1993). This is a compendious summary of the changing environments of the Pleistocene, including biodiversity and human settlement, and 55 pages of references. Norfolk sites are well represented.

Recent thinking on stratigraphic terminology for Pliocene, Pleistocene and Holocene rock units is to be found in DQ Bowen (ed): 'A Revised Correlation of Quaternary Deposits in the British Isles' (Geological Society of London Special Report No.23; 1999).

The vertebrate fossils of the famous Cromer Forest-bed are dealt with in 'Fossil Vertebrates of the Cromer Forest Bed in Norwich Castle Museum' by B McWilliams (Norfolk Museums Service; 1975).

An account of the excavation of early Pleistocene vertebrate fossils at Norton Subcourse is presented at <http://www.bohomedial.com/hippositenew/>.

Details of the geology, landslides and coastal erosion at Happisburgh and Sidestrand can be found at <http://www.bgs.ac.uk/landslides/caseStudies.html>.

Details of the Lynford Neanderthal and mammoth site are at <http://www.museums.norfolk.gov.uk> and navigate to Research - Academic Articles - Archaeology - Neanderthals butcher mammoths.

'Subsidence in Norwich' by Humphreys, Howard and Partners (HMSO; 1993) is an interesting account of the effects of subsidence caused by historic chalk mining in Norwich.

A fascinating investigation into the evolution of the Waveney-Little Ouse corridor is found in 'From Brandon to Bungay. An exploration of the landscape history and geology of the Little Ouse and Waveney Rivers' by RG West (Suffolk Naturalists' Society, Ipswich; 2009).

For a classic account of the evolving geodiversity and ecology of the Fens see 'Fenland : Its Ancient Past and Uncertain Future' by H Godwin (Cambridge University Press; 1978).

[Landscape and landforms](#)

'Classic Landforms of the North Norfolk Coast' by E Bridges (The Geographical Association in conjunction with the British Geomorphological Research Group; 1998). A well-researched and illustrated guide book.

The geomorphology of Norfolk is dealt with in 'The Geomorphology of the British Isles (Eastern and Central England)' by K Clayton and A Straw (Methuen; 1979). It deals in detail with the glacial geomorphology of the Cromer Ridge and north-west Norfolk.

'Blakeney Point and Scolt Head Island' by H Allison and J Morley (eds) (The National Trust; 5th edtn, 1989) is an excellent introduction to the physiography, ecology and biodiversity of the North Norfolk coast.

[Soils](#)

Soils are one of the most fascinating and least appreciated aspects of Norfolk's geodiversity. The best reference guide is 'Soils and their Use in Eastern England' by CA Hodge, RG Burton, WM Corbett, R Evans and RS Seale (Soil Survey of England and Wales Bulletin No.13, Harpenden; 1984). It covers the soil associations and their component series, and their links with geology and land-use.

The accompanying map is 'Soils of England and Wales: Sheet 4 Eastern England' (Soil Survey of England and Wales), which displays Norfolk's variety of soils at 1:250,000 scale. Overview information about Norfolk's soils may be obtained on-line through the National Soil Resources Institute's Soilscales Viewer at <http://www.landis.org.uk/soilscales/>.

[Water](#)

The story of Norfolk's water supply is patchily told. Individual geological sheet memoirs of the British Geological Survey contain useful details, although the otherwise excellent 'King's Lynn and The Wash' volume (Gallois, 1994) is inexplicably silent on the subject. The British Geological Survey publishes specialist maps on groundwater vulnerability to pollution, and hydrogeological maps detailing availability, exploitation and quality. See <http://www.bgs.ac.uk/catalogue/home.html>. Details of the hydrogeology of the North Norfolk Chalk aquifer are explained by Hiscock 1991 (Bulletin of the Geological Society of Norfolk no. 41).

'Taking the Waters' by M. Manning (Norfolk Industrial Archaeological Society; 1994) investigates the story of spas, spa wells and holy wells in the county.

General details of catchment hydrology and water resources in Norfolk may be obtained from the Catchment Abstraction Management documents published by the Environment Agency.

[The Palaeolithic](#)

The classic introduction to the Palaeolithic of Norfolk is 'Palaeolithic Sites of East Anglia' by JJ Wymer (Geobooks, Norwich; 1985). See also 'East Anglian Palaeolithic Sites and their Settings' by John Wymer in: 'Aspects of East Anglian Prehistory' by C Barringer (ed) (Geobooks, Norwich; 1984). This book has chapters on prehistoric environments & economies and archaeology, including Norfolk. Happisburgh has yielded evidence for the earliest and northernmost human expansion into Eurasia, over 800,000 years ago. See http://news.bbc.co.uk/1/hi/science_and_environment/10531419.stm

For online information about the Palaeolithic and Mesolithic of Norfolk see http://en.wikipedia.org/wiki/Prehistoric_Norfolk.

[Landscape character](#)

Norfolk's landscapes and coastal environments were characterised into Natural Areas by English Nature in the 1990s. The Natural Area Profile documents provide an excellent access point into the details of Norfolk's geodiversity and biodiversity. See http://www.naturalareas.naturalengland.org.uk/Science/natural/NA_search.asp.

In 2005 the Natural Areas concept was adapted to include human land use and settlement. See the National Character Area profiles at <http://www.naturalengland.org.uk/ourwork/landscape/englands/character/areas/eastofengland.aspx>.

Detailed local information about Landscape Character Assessment for Norfolk may be viewed at http://www.landscapecharacter.org.uk/results/list_new.php?res=LA45.

[Designated sites and areas](#)

Sites of Special Scientific Interest – see <http://www.english-nature.org.uk/Special/sssi/search.cfm> for details (maps and designation documents) for all SSSIs in Norfolk. See also the Geological Conservation Review (GCR) website <http://www.jncc.gov.uk/page-4172> for further information about the geodiversity interest of SSSIs.

National Nature Reserves – see <http://www.naturalengland.org.uk/ourwork/conservation/designatedareas/nnr/regions/east.aspx> for a list of Norfolk reserves, with associated maps and nature conservation information.

The Broads National Park – see <http://www.broads-authority.gov.uk/index.html> for more information.

[The coastal environment](#)

For excellent information on coastal processes, geological details and management issues of the coastline from Kelling to Happisburgh, see the North Norfolk Coastal Environment website - <http://www.northnorfolk.org/coastal/microsite/doc1.html>.

For scientific information on sediment movement along the Norfolk coast see the Southern North Sea Sediment Transport Study – <http://www.sns2.org/>.

For information about coastal management see the Environment Agency website for the Wash Estuary, North Norfolk and Kelling to Lowestoft Shoreline Management Plans - <http://www.environment-agency.gov.uk/research/planning/105014.aspx>.

2) General geodiversity

'Geodiversity: Valuing and Conserving Abiotic Nature' by Murray Gray (Wiley; 2004) - the seminal reference book.

'Natural Foundations: Geodiversity for People, Places and Nature' by H Stace and J Larwood (English Nature; 2006) – a useful and attractive overview of integrated thinking on geodiversity. Available as a PDF download or free from Natural England's publications dept. (code CORP.21)

3) Geoconservation

[General geoconservation](#)

'Earth Science Conservation in Great Britain. A Strategy' (Nature Conservancy Council; 1991) – a seminal policy document. Includes appendices comprising 'A Handbook of Earth Science Conservation Techniques' compiled by AP McKirdy.

'Geological conservation: a Guide to Good Practice' by C Prosser, M Murphy and J Larwood (English Nature; 2006) – essential reading. Available as a book or a PDF download from Natural England website.

Local Geodiversity Action Plans – see Natural England web pages explaining a national policy framework for conserving geodiversity:

<http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/protectandmanage/lgaps>.

'Local Geodiversity Action Plans - Setting the context for geological conservation' by C Burek and J Potter (Research Report 560; English Nature, Peterborough; 2006). Available as a PDF download from Natural England website.

Sites of Special Scientific Interest (SSSIs) – see Natural England's web pages about nationally important sites for nature conservation:

<http://www.sssi.naturalengland.org.uk/Special/sssi/search.cfm>.

The Earth Science Conservation Classification System – see Natural England's pages explaining the theoretical framework for conserving the different types of geodiversity sites:

<http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/protectandmanage/conservation.aspx>.

The Geological Conservation Review – an online guide to the JNCC's review of the most important geological and geomorphological sites in Britain.

<http://www.jncc.gov.uk/page-2947>.

'UK Geodiversity Action Plan (UKGAP): A Framework for Action' – see the draft document of our national Geodiversity Action Plan (available December 2010):

<http://www.ukgap.org.uk>.

GeoConservation UK—see the home-page for the Regionally Important Geological and Geomorphological Sites conservation scheme: http://wiki.geoconservationuk.org.uk/index.php5?title=Main_Page.

'Safeguarding our Soils: A Strategy for England' (DEFRA 2009 and 'The First Soil Action Plan for England: 2004-2006' (DEFRA 2006) – see

<http://www.defra.gov.uk/environment/quality/land/soil/sap/index.htm>.

[Geoconservation in planning](#)

'Local Sites. Guidance on their Identification, Selection and Management' (DEFRA; 2006) – information about conserving geodiversity and biodiversity through non-statutory designated sites. Available as a PDF download:

<http://www.defra.gov.uk/rural/documents/protected/localsites.pdf>

'Planning Policy Statement 9: Biodiversity and Geological Conservation' (ODPM, 2005) – aka PPS9, how geoconservation is embedded in government planning policy. Essential reading. Available as a PDF download:

<http://www.communities.gov.uk/publications/planningandbuilding/pps9>.

'Planning for Biodiversity and Geological Conservation: A Guide to Good Practice' (Defra; 2006) – the guide associated with PPS9. Available as a PDF download:

<http://www.communities.gov.uk/publications/planningandbuilding/planningbiodiversity>.

The Biodiversity Planning Toolkit (Association of Local Government Ecologists) - an interactive on-line resource for planners which includes geodiversity: see <http://www.biodiversityplanningtoolkit.com/> (in development 2010).

The European Landscape Convention – an international treaty for the protection, management and planning of Europe's landscapes. See http://www.coe.int/t/dg4/cultureheritage/heritage/landscape/default_en.asp.

EU Water Framework Directive 2000 – a legal framework for the protection of rivers and lakes, estuaries, coastal waters and groundwater. See http://ec.europa.eu/environment/water/water-framework/index_en.html.

Planning and Policy Guidance 20: Coastal Planning (DoE; 1992) - conserving the coastal environment through planning. Available as a PDF download: <http://www.communities.gov.uk/documents/planningandbuilding/pdf/147498.pdf>

[Geoconservation and biodiversity](#)

'Geological conservation benefits for biodiversity ENRR 561' by R N Humphries and L Donnelly (English Nature Research Report No. 561; 2004). Available as a PDF download from Natural England website.

'Geology and biodiversity - making the links' (English Nature; 2004) – an 8-page booklet available as a PDF download from Natural England website.

'Habitat Creation Handbook for the Minerals Industry' by GJ White and JC Gilbert (eds) (The RSPB, Sandy; 2003) - discusses restoration planning, site management during mineral extraction, habitat creation techniques, case studies.

'Linking Geology and Biodiversity' by R Cottle (English Nature Research Report No. 562; 2004) – investigates the strong ties between geology and biodiversity. Available as a PDF download from Natural England website.

'The State of England's Chalk Rivers: A report by the UK Biodiversity Action Plan Steering Group for Chalk Rivers' (Environment Agency; 2004) – Norfolk has 421km of chalk rivers; information on management. Contact enquiries@environment-agency.gov.uk or tel. 08709-506 506 for a copy.

[Geoconservation and the minerals industry](#)

'Geodiversity and the Minerals Industry' (English Nature, Quarry Products Association, Silica and Moulding Sands Association; 2003). Available as a PDF download from Natural England website.

'Good Quarry' – this is a joint project of the University of Leeds and the Mineral Industry Research Organisation, aimed at all who have an interest in the environment and quarrying. See <http://www.goodquarry.com/>.

Research Framework for the Archaeology of the Extractive Industries in England (Mining and Quarrying) - a joint English Heritage and NAMHO project: <http://www.vmine.net/namho-2010/research.asp>.

4) Geodiversity in education

On-line educational material that relates to Norfolk's geodiversity is in short supply.

Norfolk Heritage Explorer includes Resource Packs for the National Curriculum, one of which is Prehistoric Flints. See <http://www.heritage.norfolk.gov.uk/>.

The British Geological Survey's website 'The Blakeney Esker Explored' provides educational resources and information about this important Pleistocene landform.

See http://www.bgs.ac.uk/education/blakeney_esker.html.

There are many Field Studies Centres in North Norfolk which provide physical geography courses, for example:

- Holt Hall (Norfolk County Council):
<http://www.holthall.norfolkedunet.gov.uk/courses.html> (coastal processes in North Norfolk; fluvial processes on the River Glaven; introduction to rocks and soils; habitat ecology)

The Norfolk Coast AONB team publishes information about field studies in North Norfolk at <http://www.norfolkcoastaonb.org.uk/mediaps/pdfuploads/pd000135.pdf>.

Soil-Net is an educational resource on soil for Key Stages 1-4 developed by Cranfield University in association with Norwich School of Art and Design. See <http://www.soil-net.com>.

General Earth heritage-related teaching websites include:

- The Earth Science Teachers' Association <http://www.esta-uk.net/>.
- Earth Learning Idea <http://www.earthlearningidea.com/>.
- Earth Science On-site <http://www.esos.ukrigs.org.uk>.

5) Geodiversity in Museums

The Norfolk Museums and Archaeology Service makes information about its geological collections available online through 'Collections Online for All'. See <http://museums.norfolk.gov.uk/> and navigate to: Research - Collections - Search our collections.

Norfolk Heritage Explorer is Norfolk's Historic Environment Records database online. See <http://www.heritage.norfolk.gov.uk/>.

Cromer Museum (East Cottages, Tucker Street, Cromer Norfolk NR27 9HB; 01263 513543). Has a new Geology Gallery, with an interpretation programme involving local geology, including guided walks on West Runton beach. See <http://museums.norfolk.gov.uk/> and navigate to: Visit Us - Cromer Museum.

Lynn Museum (Market Street, King's Lynn, Norfolk PE30 1NL; 01553 775001). Has geological specimens in the collection. See <http://museums.norfolk.gov.uk/> and navigate to: Visit Us - Lynn Museum.

Norwich Castle Museum (Castle Meadow Norwich Norfolk NR1 3JU; 01603 493625). Has a display of geological specimens and the skeleton of the West Runton elephant; has large collections in storage; employs a geological curator. See <http://museums.norfolk.gov.uk/> and navigate to: Visit Us - Norwich Castle Museum and Art Gallery.

Ancient House Museum of Thetford Life (White Hart Street Thetford Norfolk IP24 1AA; 01842 752599). Has a small case of geological specimens on display, and more in storage. See <http://museums.norfolk.gov.uk/> and navigate to: Visit Us - Ancient House Museum of Thetford Life.

Other museums in Norfolk have small collections of local geological specimens and records, particularly Diss and Swaffham.

6) Geodiversity groups

The East of England Geodiversity Partnership – see <http://www.geo-east.org.uk/>. Includes interactive map showing places to visit of geodiversity interest in Norfolk.

The Geological Society of Norfolk – see <http://www.norfolkgeology.co.uk/>.

Norfolk Mineral & Lapidary Society – see <http://norfolkminandlapsoc.homestead.com/>.

Open University Geological Society. East Anglia Branch - <http://www.ougs.org/branches/>.

Appendix 2 - Glossary

Aeolian	Referring to the wind and its action.
Aggrade; Aggradation	The accumulation of unconsolidated sediment by fluvial (qv), marine or aeolian (qv) action; the shift in a river's dynamic erosional and depositional equilibrium towards net deposition.
Aggregate	Any loose material mixed with cement to form concrete, typically sand and gravel.
Anastomosing	A network of multiple river channels that both branch out and reconnect.
Anthropogenic	Effects, processes or materials derived from human activities.
Aquifer	A water-bearing geological formation.
Biodiversity	The variety / diversity of life forms; the totality of genes, species, and ecosystems of a region.
Bituminous	Resembling or containing bitumen (tar-like hydrocarbons).
Boulder clay	See entry for Till.
Bourne	A seasonal or intermittent stream.
Braided river	A river composed of a network of small channels separated by small, often temporary islets called bars. Braided streams occur in rivers with a large sediment load.
Bund; bunding	Embankment.
Cementstone	Muddy limestone that may form fractured concretions with calcite infill, known as septaria.
Chalybeate	Containing iron salts.
Clunch	Local name for hard building material, usually chalk or stiff clay.
Coversand	Deposits of wind-blown sand.
Doggerland	The name given to the former land area in northwest Europe lying between England, Holland and Denmark, now submerged by the North Sea.
Earth heritage	The inherited assembly of geodiversity features.
Erratic	A glacially-transported rock now resting on country rock of a different lithology (qv).
Eutrophication	An increase in the concentration of chemical nutrients in an ecosystem to an extent that it increases the primary productivity of that ecosystem. Eutrophication is often a result of pollution such as sewage effluent and nitrate run-off from farmland.
Floodplain	Flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding.
Fluvial	Pertaining to rivers.
GCR	The Geological Conservation Review, which identifies over 3000 nationally important geodiversity sites in Britain. Administered by Natural England.
Geoarchaeology	A multi-disciplinary approach which uses the techniques and subject matter of geography, geology and other Earth sciences to examine archaeological evidence.
Geoconservation	Action taken with the intent of conserving and enhancing geological and geomorphological features, processes, sites and specimens.

Geodiversity	Geodiversity may be defined as the natural range (diversity) of geological features (rocks, minerals, fossils, structures), geomorphological features (landforms and processes), soil and natural water features that compose and shape the physical landscape.
Geomorphology	The physical features and natural processes operating on the surface of the Earth which enable us to understand landforms and their origin.
Glaciofluvial	Referring to meltwater streams associated with ice sheets and glaciers, and the deposits and landforms they produce.
Head	Mixed superficial deposits of periglacial (qv) origin on slopes, mobilised by solifluction (qv).
Hummocky ground	A periglacial (qv) landform characterised by undulating ridge/mound and hollow topography developed in chalky head (qv).
Interfluve	The higher area between two valleys.
Interglacial	A warm period between two glacial periods.
Isostatic	Referring to the equilibrium in the Earth's crust such that the forces tending to elevate landmasses are balanced by forces tending to depress them.
Landscape	An area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors.
Landscape character	A distinct, recognisable and consistent pattern of elements in the landscape that makes one landscape different from another, and hence unique.
Lithology	The character of a rock, its composition, structure, texture and hardness; the study or description of rock.
Little Ice Age	A period of cooler climate in the northern hemisphere lasting from c. 16 th century to the 19 th century, characterised by colder winters.
Local Site	A designated non-statutory nature conservation site of local importance, such as RIGS (qv) or County Wildlife Site; as defined by DEFRA.
Loess	A windblown deposit of silt or clay.
Longshore drift	The transport of sand and shingle along a beach or coast by means of waves and currents.
Mass movement	The downslope movement of loose rock, soil and surface debris by processes such as slumping, sliding, solifluction (qv), soil creep and hillwash. It also includes landslides.
Mineral; minerals	A mineral is a naturally occurring solid formed through geological processes that has distinctive chemical composition, internal crystal structure and physical properties. Minerals combine with each other to form rocks. In economic and planning terms, 'minerals' refers to excavated geological resources such as sand, gravel, chalk or sandstone.
Moraine	An accumulation of sediment and rock debris formed by the eroding and transporting action of a glacier or ice sheet.
Naled	A sheet-like mass of layered ice formed from successive flows of groundwater in a valley bottom during freezing temperatures; otherwise known as an aufeis or icing.
Ness	A promontory or headland; in Norfolk these are formed by longshore drift (qv) processes.
OD	Abbreviation for Ordnance Datum, the sea level datum point established by the Ordnance Survey at Newlyn, Cornwall.

Outwash fan	An apron or fan of sediment deposited by glacial meltwater in front of a glacier or ice sheet.
Palaeosol	A former or fossil soil preserved by burial beneath later sediments. Analysis of such deposits may have great value in reconstructing past environments.
Palsa	Low mounds developed from groundwater over permafrost (qv) in boggy environments; like pingos (qv), palsas consist of a core of ice with overlying peat, but they are smaller than pingos and often occur in groups.
Patterned ground	The arrangement of superficial deposits into structures such as circles, stripes and polygons due to freeze-thaw action in a periglacial (qv) environment.
Periglacial	In the vicinity of a glacial environment, with conditions dominated by freeze-thaw processes.
Permafrost	Permanently frozen ground.
Pingo	A mound of earth-covered ice formed in regions of permafrost (qv); they typically form over artesian springs or in former lake beds; in the Arctic they can reach up to 70m in height and up to 600m in diameter. See also entry for palsa.
Physical landscape	The geological and geomorphological components of landscape, including landforms, soils and water.
Raised beach	A former beach raised above the current shore line by a relative fall in sea level.
RIGS	A non-statutory Local Site (qv) designation, meaning Regionally Important Geological / geomorphological Site.
River terrace	The remains of a river's former floodplain (qv) sited above current floodplain level, formed when a river shifts its dynamic equilibrium towards net erosion and incises to a lower level.
Roddon	Deposits of marine alluvium in Fenland formed in former tidal creeks, seen now as meandering channels of silty soil in reversed relief surrounded by wasted fen peat.
Sedimentary structure	A structure in sedimentary rocks, such as cross-bedding and ripple marks, produced either contemporaneously with deposition or shortly afterwards.
Solifluction	The slow movement of an active layer of waterlogged sediment downslope, over impermeable material such as permanently frozen ground (permafrost (qv)). It occurs in periglacial environments where surface layers melt in summer.
Stratotype	A type section of a geological stratigraphic unit; used for scientific reference purposes.
SSSIs	Sites of Special Scientific Interest, comprising over 4000 nationally important sites designated for their wildlife and geological interest; administered by Natural England.
Swallow hole	A natural hole into which a stream flows, formed by solution of the underlying bedrock such as chalk or limestone.
Stratigraphy	The study of the rock layers (strata) in the Earth.
Terracette	Small-scale, step-like landforms developed by soil creep on steep, grassy slopes.
Till	Unsorted, unstratified material deposited directly by glacial ice; in the past called 'boulder clay'.
Tufa	Soft, white, porous formation of calcium carbonate deposited from solution in spring water or percolating groundwater.

Appendix 3 - Stratigraphic Chart

The following chart gives a concordance between informal names of rock units used in this document and their formal stratigraphic equivalents defined by the British Geological Survey. For more information consult the BGS Lexicon of Named Rock Units at <http://www.bgs.ac.uk/lexicon/>.

a) Bedrock deposits

Periods	Age (m yrs ago)	Informal names of rock units	Stratigraphic names of rock units
Pleistocene	1.8	Wroxham Crag	Crag Group (part)
Pliocene		Norwich Crag	
	2.2	[A gap in time in which deposits were eroded away]	
Eocene	c.40	London Clay	Thames Group (part)
		[A gap in time in which deposits were eroded away]	
	65		
Upper Cretaceous		Upper and Middle Chalk	White Chalk Subgroup
		Lower Chalk	Grey Chalk Subgroup
	99	Red Chalk	Hunstanton Formation
Lower Cretaceous	105	Gault	Gault Formation
	110	Carstone	Carstone Formation
	115	Roach	Roach Formation
	130	Dersingham Beds	Dersingham Formation
	135	Mintlyn and Leziate Beds (Sandringham Sands)	Sandringham Sand Formation
	144	Roxham and Runcton Beds (Sandringham Sands)	
Jurassic	153	Kimmeridge Clay	Kimmeridge Clay Formation
	159	Amphill Clay	Amphill Clay Formation
	161	West Walton Beds	West Walton Formation

b) Pleistocene superficial deposits

For information on formal stratigraphic terminology for Pleistocene superficial deposits consult DQ Bowen (ed): 'A Revised Correlation of Quaternary Deposits in the British Isles' (Geological Society of London Special Report No.23, 1999). Note that the Hunstanton Till is given here as part of the Hunstanton Formation, while the BGS Lexicon of Named Rock Units gives it as part of the Holderness Formation; we understand this discrepancy is currently being resolved by the BGS.

Appendix 4 - Sites of geodiversity importance in Norfolk

The Norfolk Geodiversity Audit

In 2007/08 the Norfolk Geodiversity Partnership commissioned a geodiversity audit. It was carried out through a survey of published literature and consultation with geological specialists. Some 328 entries were made in what will be an ongoing process. At present, it represents an initial digest of significant geological and geomorphological sites and features in the county, including SSSIs.

Preliminary work has also begun on identifying areas with significant concentrations of features. These 'landscape assemblages' are arranged on a geomorphological basis, and represent an attempt to think holistically about associations of geological and geomorphological features in the landscape; they may be used to inform statements of Landscape Character. Geomorphological themes identified include Coastal, Fluvial, Glacial, Ground-ice, Karst and Topographic.

Much work remains to be done. The results of the audit will be subject to a programme of verification, including identifying and contacting land owners / managers, and hopefully checking details of visible features and site condition. The results will help inform the Partnership's Local Sites designation process, and represent baseline information about designated sites and 'geological interests within the wider environment'¹ for use by local planning authorities. The listing of a site does not imply any official conservation status or designation, nor right of public access.

Results to date have been prepared in a spreadsheet database organised on a Local Authority basis. The number of audited sites and features (including SSSIs) broken down by local authority is shown right (as at July 2009).

Breckland District	77
Broadland District	38
Gt Yarmouth Borough	5
Kings Lynn & West Norfolk Borough	77
Norwich City	15
North Norfolk District	56
South Norfolk District	61

The results of the audit are available on request from the following sources:

- Norfolk Geodiversity Partnership - contact Jenny Gladstone: tel.: 01603-619387; email: jennygladstone@aol.com or Tim Holt-Wilson: tel.: 01379-870411; email: timholtwilson@onetel.com.
- Norfolk Biodiversity Information Service - <http://www.nbis.org.uk/>.

An online version is available through the Geo-East website -

- <http://www.geo-east.org.uk/spages/norfolk.htm>.

The results of the audit present publicly available information. If there are any queries about its contents or purpose please contact Jenny Gladstone or Tim Holt-Wilson, as above.

The following pages present a summary of information about designated sites of geodiversity importance.

¹ Planning Policy Statement 9: Biodiversity and Geological Conservation' (ODPM, 2005), section 1.ii.

Designated sites of international, national, regional and local importance for geodiversity

1) Statutory sites

EARTH HERITAGE SSSIs in Norfolk, based on the GCR

The GCR categories given below are termed 'Blocks'; for more information see <http://www.jncc.gov.uk/page-4171>.

Site name	OS grid ref	GCR categories	Summary of interest
Bawsey Beeston Cliffs	TF680194 TG167434 to TG171433	QEA QEA	Bawsey Calcareous Till and Woodland Farm Till (Anglian) Type site of Beestonian Stage
Bilsey Hill	TG023416	QEA	Deep sections in the north Norfolk till plain adjacent to Wiveton Downs and Glaven Valley
Blackborough End Pit	TF670145	BER	Carstone resting on Leziatite Beds. Dersingham Beds absent
Bramerton Pits	TG295060 to 298061	PLV + QEA	Type site for the Norwich Crag and Bramertonian temperate stage. Vertebrate fauna present.
Briton's Lane Gravel Pit	TG169145	QEA	Briton's Lane Gravels of the Cromer Ridge
Broome Heath Pit	TM345913	QEA	Broome Terrace of Waveney valley
Caistor St Edmund Chalk Pit	TG239048	CEN + QEA	Late Campanian Beeston Chalk and mid Pleistocene sequence with palaeosols
Catton Grove Chalk Pit	TG229109	CEN	Type site for late Campanian Catton Sponge Bed
Dersingham Bog	TF675289	BER	Type site for Dersingham Formation
East Runtun Cliffs	TG340280	PLV + QEA	Pre-Cromerian vertebrate fauna (Pastonian)
East Walton & Adcock's Commons	TF734164	QEA	Ground-ice depressions (late Devensian)
Glandford Hurdle Lane	TG054416	QEA	Pleistocene glaciogenic deposits
Glandford Letheringsett Road	TG043411	QEA	North Norfolk Pleistocene till plain
Grimes Graves	TL810902	QEA	Periglacial patterned ground
Grimston Warren Pit	TF673223	BER	Dersingham Formation

Happisburgh Cliffs	TG379314 to TG38331	OEA	Anglian Cromer Till and Cromer Forest Bed Formation
Heacham Brick Pit	TF679364	OEA	Barremian Snettisham Clay
Holkham Brick Pit	TF862428	OEA	Late Devensian Hunstanton Till
Hunstanton Cliffs	TF672413 to TF679424	ALB	Ferriby Chalk Formation and Carstone
Hunstanton Park Esker	TF695409	OEA	Devensian glacial esker landform
Kelling Heath	TG100420	No GCR citation	Pleistocene glacial outwash plain
Leet Hill, Kirby Cane	TM381929	OEA	Middle Pleistocene fluvial and glaciogenic sediments
Morston Cliff	TF990441	OEA	Ipswichian interglacial raised beach
Mundesley Cliffs	TG317365 to TG331352	OEA	Cromer Forest-bed Formation
North Norfolk Coast	TF690443 to TG095440	COG	Salt marshes and modern coastal processes
Overstrand Cliffs	TG248411	OEA	Deformed Anglian glaciogenic sequence
Setchey	TF633132	OEA	Flandrian sea level change
Sidestrand and Trimmingham Cliffs	TG252408 to TG305375	OEA + PLV + CEN	Pre-Pastonian, Pastonian and Cromerian sediments and associated vertebrate fauna; glaciotectonic Chalk rafts; active rotational slumping.
St James' Pit	TG242094	JCR	Upper Chalk Mosasaurus
Stanford Training Area	TL870940	KAR	Breckland Meres including the Devil's Punchbowl doline
Wells Chalk Pit	TF929429	OEA	Marly Drift
West Runton Cliffs	TG183432 to TG192430	OEA + PLV	West Runton Freshwater Bed with rich fossil fauna; pre-Pastonian to Anglian sequence.
Weybourne Cliffs	TG111437 to TG152435	OEA + PLV	Cromer Forest-bed and Weybourne Crag
Weybourne Town Pit	TG114431	OEA	Type locality for Marly Drift
Wiggenhall St Germans	TF588139	OEA	Holocene sea level changes (pollen and foram data)
Winterton-Horsey Dunes	TG489216 to 506181	COG	Active dune system
Wiveton Downs	TG023433	OEA	Blakeney Esker glacial landform
Wretton	TG685992	OEA + PLV	Ipswichian and Devensian terrace with abundant fossil mammals

GCR SITES not designated as SSSIs for their geological interest

Site name	OS grid ref	GCR categories	Summary of interest
Hockham Mere Welney	TL933937 TL535942	QEA QEA	Holocene pollen sequence Holocene sediment and pollen sequence

SSSIs cited in GCR but not designated for their geological interest

Site name	OS grid ref	GCR categories	Summary of interest
Wells Chalk Pit	TF929429	QEA	Chalk grassland biodiversity

GCR CITATIONS in Norfolk compared with regional totals

GCR 'blocks' of interest	Norfolk total	Regional total	% regional total
Quaternary East Anglia	31	64	48
Quaternary of the Thames		17	
Neogene		12	
Pleistocene Vertebrates	6	11	54
Cenomanian, Turonian,	4	6	67
Senonian, Maastrichtian			
Coastal Geomorphology	2	6	33
Berriasian, Valanginian,	4	4	100
Hauterivian, Barremian			
Aptian, Albian	1	3	33
Karst	1	3	33
Mesozoic-Tertiary Fish/Amphibia		3	
Aves		2	
Fluvial Geomorphology		2	
Jurassic-Cretaceous Reptilia	1	2	50
Tertiary Palaeobotany		2	
Caves		1	
Mass Movement		1	
Oxfordian	1	1	100
Tertiary Mammalia		1	
Total 'blocks' of interest	51	141	36%

Note: the discrepancy between number of geological SSSIs (39) and GCR citations (51) may be explained because some sites are cited for more than one category of interest.

NATIONAL PARKS

Name	Summary of geodiversity interest	Area (ha)
The Broads	Holocene peatland and marine alluvium giving rise to open water, fen and carr habitats; broads developed in former early Mediaeval peat diggings; rivers including lower reaches of Bure, Waveney and Yare and their tributaries including Ant, Chet and Thurne.	30,300

NATIONAL NATURE RESERVES

Name	Summary of geodiversity interest	Area (ha)
Ant Broads & Marshes Blakeney	Holocene peatland including open water and associated fens and carrs. Active coastal landforms, including the shingle spit and ridges of Blakeney Point and associated saltmarshes.	178 1097
Brettenham Heath	Contrasting chalky and acidic soil types give rise to classic Breckland heath, including periglacial patterned ground producing vegetation stripes	233
Bure Marshes	Holocene peatland including open water and associated fens and carrs.	412
Calthorpe Broad	Holocene peatland including broad and associated fens and carrs.	44
Dersingham Bog	Lower Cretaceous lithologies give rise to peatland and lowland heath habitats; Pleistocene degraded cliff line forms escarpment.	159
Foxley Wood	Lowestoft till lithologies of Central Norfolk plateau give rise to woodland and meadowland habitats.	125
Hickling Broad	Holocene peatland including open water and associated fens and carrs.	586
Holkham	Active coastal landforms, including intertidal sands and muds, saltmarshes and sand dunes.	3851
Holme Dunes	Active coastal landforms including sand dunes, mudflats and saltmarsh.	192
Ludham - Potter Heigham	Holocene marine alluvium gives rise to lowland grassland habitat.	86
Martham Broad	Holocene peatland including open water and associated fens and carrs.	59
Mid-Yare	Holocene peatland including open water and associated fens and carrs.	779
Redgrave and Lopham Fen	Holocene peatland and calcareous springs including associated fens and carrs.	125
Roydon Common	Lower Cretaceous lithologies give rise to lowland heath, mire and wood habitats.	183
Scolt Head Island	Active coastal landforms, including offshore shingle bank, sand dunes, mud flats and saltmarsh.	737
Swanton Novers	Lowestoft till lithologies of North Norfolk plateau give rise to ancient woodland habitat.	84
The Wash	Active coastal landforms, including intertidal sands and mudflats, saltmarsh and open water.	8881
Weeting Heath	Pleistocene coversands over chalky till lithologies give rise to Breckland heath habitat with contrasting vegetation types.	137
Winterton Dunes	Active coastal landforms including beach and sand dunes, with associated dune heath and dune slack habitats.	109
	Total	18,057

2) Non-statutory

Designated sites of local importance for nature conservation in Norfolk include RIGS and County Wildlife Sites, and are generically termed Local Sites (see Section 4 Policy Background).

Local Sites of geodiversity importance are designated by the Norfolk RIGS Group, a sub-committee of the Geological Society of Norfolk. Designation involves surveying features of interest, and gaining voluntary agreement with the land owners / managers on beneficially managing those features to retain or enhance their interest. Its principles follow those outlined in the DEFRA advisory booklet 'Local Sites. Guidance on their Identification, Selection and Management' (2006). Designation does not confer any right of public access to the site. Norfolk has five designated RIGS, as follows:

Breckland District

Newton by Castle Acre Chalk Pit; also known as Needham Chalks Quarry

Grid reference: TF837149

Area (ha): not available

An active quarry displaying Cretaceous Chalk of the Coniacian Stage (transitional M.cortestudinarium / M.coranguinum Zones) and Santonian Stage. Fossils include Inoceramus, Micraster, ammonites, fish and bryozoans. Large, fresh exposures available.

Date of designation: 12.11.1999

Great Hockham Erratic; also known as Village Stone

Grid reference: TL95309257

Area (ha): not available

Large erratic boulder of Cretaceous Spilsby Sandstone Formation. Discovered on farmland east of the village and resited on the Village Green c.1880; ritually turned over to mark notable events in the life of the parish.

Date of designation: 23.11.2009

Broadland District

Thorpe St Andrew, Pinebanks Pit

Grid reference: TG261089

Area (ha): not available

A disused gravel pit exposing sands of Pleistocene Anglian outwash and/or Pliocene Norwich Crag displaying sedimentary structures. Site has educational potential, being close to Norwich and part of a recreational area.

Date of designation: 30.08.2000

North Norfolk District

Letheringsett With Glandford, Rising Hill Pit

Grid reference: TG033404

Area (ha): not available

Disused quarry with good exposures of Pleistocene Anglian fluvio-glacial sand, gravel and chalky mud overlain by a thin sheet of chalk-rich glacial diamicton. Interpreted as a deglacial sequence dominated by ice-contact meltwater deposits and meltout tills. Complements the nearby Bilsey Hill geological SSSI.

Date of designation: 22.01.1999

Hempton Quarry

TF904284

Area (ha): not available

Partly landfilled former quarry, exposing Pleistocene Anglian sediments, comprising a glacio-tectonised sequence of bedded silty sands overlain by fine, sandy, well-bedded gravels, all with high chalk content. Adjacent to Hempton Green County Wildlife Site.

Date of designation: 04.04.2000

Appendix 5 - Geodiversity in Planning

Guidance on conserving and enhancing geodiversity through planning in Norfolk

Development is carried out by a range of agencies, including national and local government departments, utility companies and private sector developers (housing, commercial, agricultural, industrial), but all development will impact in one way or another on geology, landscape, landforms, soil and water resources. Depending on the nature of its activity, development may enhance or may damage geodiversity. On the positive side, it may:

- create access to new geological information for research and education, via creation of temporary or permanent exposures;

On the negative side it may:

- destroy the integrity of landforms that have taken millennia to develop;
- destroy finite geological deposits and the palaeo-environmental information they contain, including associated archaeological evidence of early human settlement;
- contaminate and deplete soils and water resources.

This document is a short statement by the Norfolk Geodiversity Partnership (NGP) on how planners may successfully conserve and enhance geodiversity as part of their LDF work, and so may contribute towards sustainable development.

Policy background

Planning Policy Statement No.9: Biodiversity and Geological Conservation (PPS9)

PPS9 covers the conservation of designated geological and geomorphological sites, which include statutory SSSIs and non-statutory Local Sites e.g. RIGS and County Geodiversity Sites¹. PPS9 states that

- local planning authority policies should attach 'appropriate weight' to designated sites and also 'geological interests in the wider environment';
- plans and policies should be based on up-to-date information about the environmental characteristics of their areas, including its geodiversity;
- the aim of planning decisions should be to prevent harm to geological conservation interests; where harm to such interests is unavoidable mitigation or compensation measures should be put in place; mitigation may include modification of the design, methods and timing of development, or adjustments in its nature, scale or location; compensation includes measures to offset or make up for losses caused by the development, including residual effects which cannot be mitigated;
- criteria-based policies should be established in Local Development Framework documents against which proposals for any development on, or affecting, Local Sites will be judged.

Minerals Planning Guidance 7: Reclamation of Mineral Workings (MPG7)

MPG7 sets out policy guidance on how reclamation can be used to enhance the

¹ Local Sites, as defined in 'Local Sites. Guidance on their Identification, Selection and Management' (DEFRA; 2006)

quality of land and landscapes taken for mineral extraction. It provides for enhancement for amenity use including nature conservation, and recommends permanent retention of features of geological importance revealed by quarrying or predicted to be revealed (section B52).

Planning Policy Statement 5: Planning for the Historic Environment (PPS5)

We note that buried archaeological assets are intimately linked with the sediments and soils which form their palaeo-environmental context and which are an essential part of evaluating their significance. PPS5 defines the historic environment in terms of heritage assets to be conserved in proportion to their significance. It recognizes that these are a non-renewable resource. There are many heritage assets which are not currently designated as Scheduled Monuments; however the absence of designation does not mean they have lower significance.

Recommendations for Norfolk planners

- 1) Planners should have access to baseline information about geodiversity features in their areas. This is available through British Geological Survey maps and publications, and the Norfolk Geodiversity Audit carried out by the NGP, and which is available as a GIS layer through the Norfolk Biological Information Service. Advice on geodiversity features 'in the wider environment' is also available from these sources. The audit also includes information about the overlap between palaeo-environmental and Palaeolithic archaeological evidence.
- 2) Planners need to understand how development may impact on and threaten geodiversity, particularly certain finite types of landforms and geological resources. They are recommended to familiarise themselves with the basic principles of geological conservation as set out in *Geological conservation: a Guide to Good Practice* by C Prosser, M Murphy and J Larwood (English Nature; 2006). The NGP can advise on the relative importance and vulnerability of geodiversity resources at national, county and local levels, and Norfolk Landscape Archaeology can give specialist advice on potential impact of development on archaeological heritage assets.
- 3) Planners should set up procedures to integrate geodiversity in the planning process. Such procedures should include:
 - (a) Establishing a requirement for developers to carry out early consultation on the likely impact of their proposed development on geodiversity. This is best achieved through including geodiversity in the 1App planning application validation checklist as has been done in Suffolk².
 - (b) Establishing effective mitigation measures via Section 106 agreements as part of gaining planning permission. Such measures may include
 - Agreeing access to site before and during works for recording and sampling by representatives of the NGP;
 - Designing development to avoid damage to or obstruction of geodiversity features, and to allow access for future study and recording; if damage is unavoidable then creating replacement geological exposures of equivalent value, or otherwise enhancing local geodiversity features, e.g. through conservation of features or interpretation;

- Provision for long-term maintenance and management of geodiversity features such as geological sections;
 - Agreement on access for future scientific and educational study;
 - Provision of interpretation appropriate to the scale of the development;
 - Agreeing geodiversity objectives in after-use plans for mineral extraction sites, as per MPG7.
- (c) Including baseline geodiversity indicators in the LDF Sustainability Appraisal system. Please consult the NGP for further information.
- (d) Establishing the Condition of Local Sites as a local government performance framework target for NI 197 (Local Sites). Please consult the NGP for further information.
- (e) Developing internal policy documents (e.g. SPDs) to cover geodiversity as well as biodiversity.
- (f) Including geodiversity features (e.g. geological exposures, natural landforms, river restoration) in Green Infrastructure initiatives.
- 4) Planning authorities are invited to join the Norfolk Geodiversity Partnership and to subscribe to the objectives of the Norfolk Geodiversity Action Plan.

FURTHER INFORMATION

Norfolk Biological Information Service

See <http://www.nbis.org.uk/>; tel.: 01603 224458; email: nbis@norfolk.gov.uk.

Norfolk Geodiversity Partnership

Contact Jenny Gladstone: tel.: 01603-619387; email: jennygladstone@aol.com or

Tim Holt-Wilson: tel.: 01379-870411; email: timholtwilson@onetel.com.

British Geological Survey

Contact Keith Ambrose: tel.: 0115-936 3203; email: kam@bgs.ac.uk or

Jonathan Lee: tel.: 0115-936 3517; email: jrlee@bgs.ac.uk.

Natural England

See <http://www.naturalengland.org.uk/>; tel.: 01603 674920; email:

enquiries.east@naturalengland.org.uk.

GLOSSARY

Geodiversity

Geodiversity is the variety of rocks, fossils, minerals, landforms and soils along with the natural processes that shape the landscape.

Nature conservation

The protection, preservation, management or enhancement, and the improvement of understanding and appreciation of, flora, fauna and geological and geomorphological features.

[Definitions taken from 'Planning for Biodiversity and Geological Conservation - A Guide to Good Practice' (ODPM 2006)]

REFERENCES

Geoconservation

Geological conservation: a Guide to Good Practice by C Prosser, M Murphy and J Larwood (English Nature; 2006). Available from Natural England website: <http://naturalengland.etraderstores.com/NaturalEnglandShop/product.aspx?ProductID=712db525-75de-4079-862e-5b654546ea56>.

Local Geodiversity Action Plans – see Natural England web pages explaining a national policy framework for conserving geodiversity: <http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/protectandmanage/lgaps.aspx>.

Local Geodiversity Action Plans - Setting the context for geological conservation by C Burek and J Potter (Research Report 560; English Nature, Peterborough; 2006). Available as a PDF download: <http://www.mineralsandnature.org.uk/downloads/localgeodiversity.pdf>.

Sites of Special Scientific Interest (SSSIs) – search Natural England's web pages about nationally important sites for nature conservation, including geodiversity: <http://www.sssi.naturalengland.org.uk/Special/sssi/search.cfm>.

The Earth Science Conservation Classification System – see Natural England's pages explaining the theoretical framework for conserving the different types of geodiversity sites: <http://www.naturalengland.org.uk/ourwork/conservation/geodiversity/protectandmanage/conservation.aspx>.

The Geological Conservation Review – an online guide to the JNCC's review of the most important geological and geomorphological sites in Britain. <http://www.jncc.gov.uk/page-2947>.

UK Geodiversity Action Plan (UKGAP): A Framework for Action – see the draft document of our national Geodiversity Action Plan (available December 2010): <http://www.ukgap.org.uk>.

GeoConservation UK—see the home-page for the Regionally Important Geological and Geomorphological Sites conservation scheme: http://wiki.geoconservationuk.org.uk/index.php5?title=Main_Page.

Geoconservation in planning

The Biodiversity Planning Toolkit—an interactive, on-line resource for planners which includes geodiversity: <http://www.biodiversityplanningtoolkit.com/> (in development 2010).

Draft Supplementary Planning Guidance for Nature Conservation – Geodiversity and Development in the United Kingdom (UKRIGS Geoconservation Association; undated) – A code of practice for early consultation. Available as a PDF download: www.ukrigs.org.uk/public/ncguidance.pdf.

Local Sites. Guidance on their Identification, Selection and Management (DEFRA; 2006) – information about conserving geodiversity and biodiversity through non-statutory designated sites. Available as a PDF download:

<http://www.defra.gov.uk/rural/documents/protected/localsites.pdf>.

Minerals Planning Guidance 7: Reclamation of Mineral Workings (ODPM; 1996) - Available as a PDF download: <http://www.communities.gov.uk/publications/planningandbuilding/mineralsplanningguidance5>.

Planning Policy Guidance 16: Archaeology and Planning (ODPM; 1990). Available as a PDF download:

<http://www.communities.gov.uk/publications/planningandbuilding/ppg16>.

Planning Policy Statement 5: Planning for the Historic Environment (ODPM; 2010). Available as a PDF download: <http://www.communities.gov.uk/publications/planningandbuilding/pps5>.

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Planning for Biodiversity and Geological Conservation: A Guide to Good Practice (DEFRA; 2006) – the guide associated with PPS9. Available as a PDF download: <http://www.communities.gov.uk/publications/planningandbuilding/planningbiodiversity>.

Planning and Policy Guidance 20: Coastal Planning (PPG20) (DoE; 1992). Available as a PDF download: <http://www.communities.gov.uk/documents/planningandbuilding/pdf/147498.pdf>.

Norfolk Geodiversity Partnership
Version 1, July 2010

Appendix 6 - Principles of geodiversity conservation

The Earth Science Conservation Classification System (ESCC)¹ has established a framework for deciding the conservation management requirements of geodiversity. It divides sites/features into three categories:

ESCC category	Exposure / Extensive Sites & Features
Site types	
Relevant to Norfolk	
Conservation principle	Geology, with features extensive beneath surface
Conservation strategy	<ul style="list-style-type: none"> • Active quarries and pits • Coastal cliffs and foreshore • River and stream sections • Extensive buried interest • Road, rail, canal cuttings
Conservation principle	Removal of material does not damage integrity of the resource
Conservation strategy	Manage to maintain acceptable exposure of resource
ESCC category	Integrity Sites & Features
Site types	
Relevant to Norfolk	
Conservation principle	Geomorphology, soils and water
Conservation strategy	<ul style="list-style-type: none"> • Static (fossil) geomorphological • Active process geomorphological • Karst
Conservation principle	Damage to one part may affect whole resource
Conservation strategy	Holistic management to maintain integrity of resource
ESCC category	Finite Sites & Features
Site types	
Relevant to Norfolk	
Conservation principle	Geological features limited in extent
Conservation strategy	<ul style="list-style-type: none"> • Finite mineral, fossil or other geological • Finite buried interest
Conservation principle	Features may be unique and irreplaceable
Conservation strategy	Permit scientific use but conserve long-term

Strategies

As the above explains, different geodiversity resources have differing vulnerabilities, which suggests different strategies for their conservation.

- Geological strata may be thought of as physical archives of sediment and fossil information. Some are more vulnerable than others. In the case of laterally extensive deposits such as the Chalk or boulder clay we need to conserve access to them rather

¹Nature Conservancy Council: *Earth science conservation in Britain, a strategy*; Peterborough (1990); and amended: English Nature: *Geological conservation, a guide to good practice*; Peterborough (2006).

than preserve them outright. This is because their resources are relatively infinite. The conservation priority in this case is to maintain access points (exposures) for scientific study. However, in cases of finite deposits, such as an ancient lake deposit or a lens of interglacial sediment with animal bones and evidence of associated human flint knapping, we need to preserve the resource in situ or, if physical preservation is not a practical option, record it fully prior to destruction (i.e. preservation by record).

- Geomorphological features are particularly vulnerable to damage. They are either one-off features created in past environments, or are currently active features being created by natural processes, and so can be damaged if the formative processes on which they depend are stopped or interrupted. We need to preserve the integrity of landforms and their relationship with their formative processes, with reference to the most natural examples. It is not about preserving the outward form or appearance of landforms, rather their wholeness as structured outcomes of natural processes, past and present.
- Soils have a complex history of development often over many millennia. Here, the conservation priority is to preserve their integrity (quality and diversity), protecting the resource from depletion, erosion and contamination.
- Groundwater, and river, lake and spring water are vital components of geodiversity, but they are vulnerable to depletion and contamination, with consequent impacts on biodiversity, landscape and the economy. The priority is to conserve the integrity of the natural hydrology and chemistry of groundwater and surface waters through systemic management.
- Landscapes are ever-evolving products of interacting cultural, biological and geological factors. However they are vulnerable to a steady erosion of their distinctive qualities and the integrity of their landform assemblages, particularly outside designated areas such as AONBs. We need to conserve their local distinctiveness and integrity through descriptions of local character which include geodiversity, particularly landforms.
- Features associated with economic geology such as quarries, tramways and brick kilns are part of the history of human activity. They are vulnerable to economic and industrial change, and preservation by record may be the best way to conserve their geodiversity interest where physical preservation as the first resort is not practical.



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Members of the Norfolk Geodiversity Partnership:

