Towards a GHG Reduction Strategy for the Broads – Identifying and Prioritising Actions

Final Report

On Behalf of:
The Broads Authority

May 2010

1. Introduction

1.1 Background

Within its overall ambition to manage the Broads in a sustainable way, the Broads Authority (the BA) has identified a need to take a positive approach to the management of greenhouse gas (GHG) emissions. This need is underpinned by a number of strategic documents including the Broads Authority's Local Development Framework (LDF) Core Strategy 2007 – 2021 Development Plan Document which identifies a number of strategic objectives and policies in relation to adapting to and mitigating climate change including a Core Strategy Policy on Response to Climate Change.

In addition to the BA's own ambitions, the Department for Environment, Food and Rural Affairs (Defra) have also clearly identified that the National Parks (of which the Boards is one) should be acting as beacons for authorities and local communities in the way they address the priorities of government in moving towards sustainable development and carbon management.

In order to achieve its ambitions and to tackle the issues of climate change for the benefit of the Broads community as a whole, the BA has identified a need to develop a greenhouse gas (GHG) management strategy where such a strategy would account for current emissions from the various sources, identifying the scope for any reductions and, therein, how and where the BA can best intervene to promote reductions in GHG emissions.

The first step towards such a GHG strategy is to assess current emissions from relevant sources to inform and guide the development of the strategy. This study provides an assessment of emissions from the different sources of most relevance in the Broads context (and hence where the BA has most opportunity to promote actions) and, building on this, identifies the focus and next steps for the BA strategy to reduce GHG emissions in the Broads.

1.2 Structure and Boundaries of the Assessment

Defining the structure and the boundaries of the GHG audit was the subject of a (Phase 1) scoping study for the BA. The scoping study concluded that:

- because the BA has influence in the Broads more widely, the audit/strategy needs to consider emissions beyond the 'usual', operationally restricted, sphere of an audit and also consider wider GHG emissions a larger geographical and landscape scale than the operations of the BA alone;

- when considering these wider emissions, the audit/strategy should take into account the fact that, whilst the BA has executive powers (including being a Planning Authority) to carry out its statutory duties[1], its geographical area of jurisdiction overlaps with the other jurisdictions (with other duties and executive

[1] It is the general duty of the Authority to manage the Broads for the purposes of:

- Conserving and enhancing the natural beauty, wildlife and cultural heritage of the Broads;
- Promoting opportunities for the understanding and enjoyment of the special qualities of the Broads by the public; and
- Protecting the interests of navigation.

The Broads Act also sets down the need for the Authority to have regard to the needs of agriculture and forestry, and the economic and social interests of those who live or work in the Broads.

powers). As such, the BA has greater scope to influence emissions from some sources and less scope for others. Accordingly, the audit/strategy should focus most effort on gaining sufficient detail in the areas where the BA has most influence while also taking note of the scale of other emissions sources;

- on this basis, it is desirable to categorise the emission sources into those that are broadly within the scope of the BA's influence directly (for example, from recreation, navigation, land management) and those that are less within the BA's power to influence directly[2] (such as the industrial, waste, domestic or transport emissions that are more the remit of other, overlapping, authorities). This is not to say that such emission sources should be excluded but merely that less detail is required for those emissions (or rather more detail is required for those areas/issues where the BA has most influence);

- this categorisation can be achieved by making a loose division between those emissions that are connected with the 'services' that the broads provides and those that are not (or are only distantly) 'connected';

- thus, emissions associated with Broads tourism and recreation or conservation and land use are examples of emissions that sit firmly within emissions that are 'connected with' the Broads and emissions from domestic sources or transport unrelated to the above are examples of emissions that are connected to the Broads only by geography and, hence are not directly connected to the services that the Broads provides;

- in terms of geographic boundaries, when considering the emissions that are 'connected with' the Broads (such as tourism and recreation), it is important to account for emissions that do not necessarily occur within the boundaries of the Broads Executive Area. For example, most visitors coming to the Broads do so from outside the executive area and thus one should consider emissions for the entire visit (from home to Broads and back) and not just the emissions within the Broads Executive Area;

- the scoping study also identified the importance of estimating stored carbon in soils and vegetation to ensure that the importance of the resource is reflected in the audit and conserved in the strategy.

2 But not totally outside of the BA's power to influence.

In this way, the scoping study and the complete assessment provided here uses the following divisions between various emissions:

Emissions 'connected with' the Broads (more BA influence - more detail required)	Emissions 'NOT/Less connected with' the Broads (less BA influence – less detail required)
Tourism and Recreation **Private boat owners** Use of boats Transport to/from boats **Hire boats** Hire boat emissions Boatyards Visitors' transport to/from boats **Other tourism and recreation** Accommodation Food and drink Recreation (spending on) Travel to/from Broads **All visitors** Travel around the Broads **Land and Land Use** **'Natural'** Woodland / dense scrub Marsh / fen Rivers Broads **Agriculture** **Agri/semi-natural** Drainage channels **Other management and activities** **Other conservation organisations/operations** **Water level management** **BA Operations** **Broads Carbon Stores** **Soil** **Vegetation**	**Emissions from industry & commerce** With the exception of some key point source emitters that the BA may be able to influence (e.g. Cantley Sugar Beet factory) which have been considered alongside Broads Connected emissions. **Emissions from domestic sources** While not outside of the BA's scope of activity, domestic sources are more the preserve of other authorities with whom the BA works **Emissions from transport** UK GHG emissions data by area provides emissions from estimated travel <u>within</u> that area but not travel to that area. The latter has been considered as connected with the broads and an estimate of Broads-related travel <u>within</u> the Broads has been estimated there.

Since the scoping study and the completion of this assessment and strategy, Defra has published a new vision for National Parks in the form of *English National Parks and the Broads UK Government Vision and Circular 2010* (March 2010) and also coarse emissions estimates for all National Parks and the Broads. The 2010 vision identifies a number of general actions on the part of National Park and Broads Authorities including:

- *"the Government believes that the Parks must now place climate change as central to their objectives";*

- *“the Authorities are educators and in the area of climate change they have a vital role to play. They should spread important messages about the impacts of climate change and how individuals, especially visitors, can play their part in tackling it in ways which motivate lifelong behaviour change”;*

- *“the management of the Parks can play a key role in the fight against climate change and in leading others by demonstrating best practice”; and*

- *“the Authorities also have a role to play in reducing emissions from sectors other than the land”; and*

- *“the Parks offer important opportunities for renewable energy generation which must not be overlooked, including woodfuels, and micro-hydro, anaerobic digestion (which will also reduce waste), wind and solar power installations appropriate to the national value of the landscape”.*

As such, although undertaken prior to the publication of the 2010 vision, the scoping, the assessment of emissions, the resulting strategy presented in this document and subsequent actions are consistent with the new vision set out in the Government’s 2010 vision.

In addition to these general roles and actions, a number of more specific actions and roles are identified in the vision. These fit well with actions already proposed in this (and previous drafts) of this strategy document and are referred to at relevant points in the text below.

1.3 Estimated Overall GHG emissions and the Broads

Each of these emissions sources has been considered and estimates derived. Grouping these emissions into categories of emissions Table 1.1 provides an overview of the emissions for context. The table provides estimates at a number of ‘levels’ each reflecting the following scales:

- **Level 1:** Emissions from Broads Authority Operations;

- **Level 2:** Wider GHG Emissions in the Broads Executive Area –GHG emissions and sequestration for the wider Broads Area and the services provided by the Broads divided into:

    a. ***Level 2a:*** emissions connected with the Broads and its services (as described above).

    b. ***Level 2b:*** emissions occurring within the Broads Executive Area but generally unconnected with Broads services (as described above);

When considering these data, it should be noted that **there is uncertainty associated with all estimation and resulting estimates.** The purpose of the data is to help inform a strategy to reduce GHG emissions rather than provide a very precise estimate for any other purpose. Care is required for other uses and when reporting. In terms of comparing totals for different levels, for example, there is some overlap between estimates for Levels 2a and 2b that cannot be eliminated. This means that, whilst the levels of accuracy permit broad comparison of the relative contributions of each for the purpose of context and focussing strategy, they should not be added together or expressed in precise percentage terms for any other use.

Caveats explained, the data suggests emissions at the various levels with the following approximate magnitudes:

- Broads Authority operations (Level1): **~1,900 tCO_2e[3];**
- Activities and operations connected with Broads services (including the above): **~131,000 tCO_2e**; and
- Other activities in the Executive Area (but not specifically connected with the Broads itself): **~359,000 tCO2e**.

In addition to GHG emissions, the carbon stored in soils and vegetation within the Broads Executive Area has also been estimated. This suggests a total carbon store within the Broads Executive Area of the order of **40 million tCO_2e.**

Table 1.1: Overview of the likely magnitude and context of GHG emissions and carbon stores (t CO_2e)

Broads Emissions	Level 2a: estimated magnitude of GHG emissions 'connected with' the Broads	Level 1: Broads Authority Operations	1,900	131,000
		Other management and organisations	1,900	
		Tourism and Recreation	54,000	
		Land and Land Use	73,500	
	Level 2b: estimated magnitude of emissions 'NOT connected with' the Broads	Emissions from industry & commerce*	75,000	360,000
		Emissions from domestic sources	55,000	
		Emissions from transport**	76,000	
		Point source emissions (British Sugar Cantley factory)	154,000	
Broads Carbon Stores		Soil	38,800,000	39,900,000
		Vegetation	1,100,000	

All of these emissions can be put into a wider context by comparing them with standard emissions data over a wider area of reference (beyond that of the Executive Area alone). Here, if a the wider reference area is taken as that dictated by Grid references TG170310 East to the Coast and North to TM170870 and east to the coast, emissions for all sources derived using GIS analysis of the National Atmospheric Emissions Inventory (NAEI) suggests a total emission of **5 million tCO_2e from all sources in this wider reference area**.

A breakdown of the emissions over this wider area is provided in Table 1.2 covering CO_2, CH_4 and N_2O emissions from all sectors. As with data at other levels, broad contextual comparisons can be made between the various levels but there is some overlap between different emissions and levels that makes precise numerical comparison problematic.

Table 1.2: Total Emissions from the Wider Reference Area

	CO_2	CH_4	N_2O	Emissions

[3] The term CO_2e refers to carbon equivalents. Where this term is used it implies that all six major greenhouse gases are included in the calculation. CO_2e is used to simplify the need to list all six greenhouse gases. In the context of this work CO_2e refers mainly to carbon dioxide (CO_2); methane (CH_4) and nitrous oxide (N_20).

	(tCO_2e)	(tCO_2e)	(tCO_2e)	(tCO_2e)
Emissions from industry & commerce	1,160,000	253,000	15,000	1,420,000
Emissions from domestic sources	1,220,000	0	0	1,220,000
Emissions from transport	923,000	1,200	19,000	943,000
Emissions from agriculture	19,000	82,000	224,000	324,000
Emissions from nature	0	100	0	100
Point source emissions	1,090,000	1,500	3,100	1,090,000
TOTAL EMISSIONS	**4,410,000**	**338,000**	**261,000**	**5,000,000**

Source: NAEI 2009

Comparison with other estimates

As noted earlier, Defra has recently published emissions estimates[4] for the National Parks and the Broads and these are provided in Table 1.3. There is no supporting documentation with these Defra/AEA Technology estimates however it is understood that they use the same GIS datasets upon which this study has drawn for 'top down' estimation of emissions. The Defra/AEA data do not, however, incorporate the more detailed 'bottom up' calculations that have been carried out in this study for those 'Broads connected' emissions where more detail is required to inform the strategy.

As such, for overall emissions such as domestic, transport and industry and commerce, the two sets of estimates produce broadly similar values in terms of scale with any differences probably reflecting slight variation in rounding of data in 1km^2 grid squares on the margins of the Broads Executive Area boundary. In contrast, Land and Land Use emissions estimated in this study also apply emissions factors and more detailed information to develop a 'bottom up' estimate of land use emissions. Details of all estimates used in the study can be found in the two part Technical Report.

Table 1.3: Comparison of Estimates for this study with Defra/AEA Technology Estimates

	Emission estimate (tCO_2e)		Comment
	This study	AEAT/Defra	
Emissions from industry & commerce (including point source emissions from Cantley)	229,000	208,200	Relatively small differences explainable by differences in GHGs considered and rounding of data in 1 km^2 grid squares
Emissions from domestic sources	55,000	67,600	
Emissions from transport	76,000	71,800	
Land and Land Use	73,500	2,500	This study uses a combination of bottom up estimation and top down to cover all emissions from all GHGs – see Technical Report for details of calculation

1.4 Focus of this report

A detailed description of the derivation of estimated emissions has been provided in a separate two part Technical Report.

This report focuses more particularly on those emissions that are 'connected with' the Broads and its services (and, hence the BA has greater power to influence). It

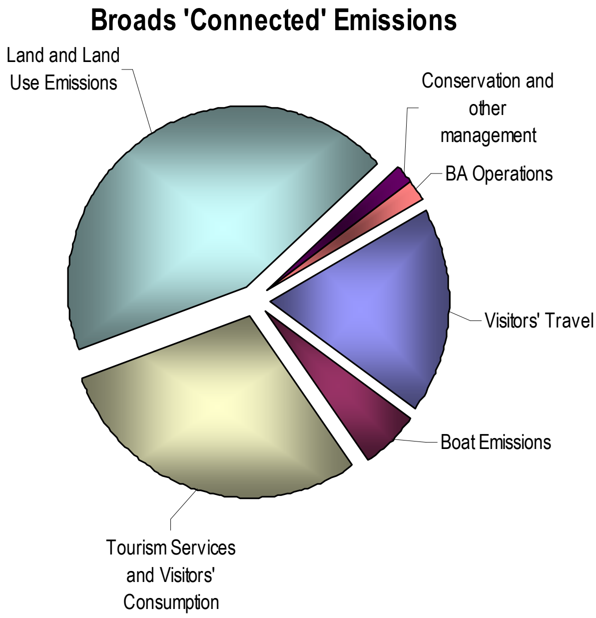
[4] http://defra.gov.uk/rural/national-parks/index.htm

considers how the BA might best set about developing a strategy for reducing GHG emissions though the promotion of actions to address each of the categories that make up the overall emission. Included in this (but considered separately) is the point source emission from Cantley Sugar Beet Factory which, although only historically connected to Broads Services (by virtue of the fact that beet was ferried historically by water) is responsible for some 154,000 t CO_2e of emissions.

When considering which actions are likely to be most effective as part of such a strategy one might ideally focus on those actions that deliver the greatest GHG emissions for the least effort (and cost). In turn, one might consider giving greater priority to any actions that reduce emissions from the larger contributors than smaller ones. This works on the basis that a small percentage reduction in a large emission may produce a larger GHG reduction than a large reduction in a smaller emission. The situation in the BA's case is, however, slightly more complex.

The summary of emissions below and associated pie chart illustrates that the emissions from the BA's own operations account for only ~1% of total emissions. In principle, then, even a large percentage reduction in the BA's own emissions can only have a small impact (maximum ~1%) on the overall emissions.

BA Operations	BA Operations	1,900
Tourism and Recreation	Visitor's Transport	18,920
	Boat Emissions	5,500
	Services	30,000
Land and Land Use	Land Use Emissions	73,500
	Conservation and other management	1,900
TOTAL		**~131,000**



In contrast (and using examples from later in the report):

- actions taken to reduce Nitrous Oxide (N_2O – a GHG with 310 times the potency of CO_2) emissions from land, water and land use by only ~0.5%... **OR**
- actions taken to reduce visitors' travel emissions to/from the Broads by ~1%...**OR**
- actions taken to help Cantley Sugar Beet factory reduce emissions by ~0.1%...

…would achieve around the same level of GHG reduction as actions that reduced the BA's operational emissions by 10%.

In the absence of any other considerations, then, a GHG reduction strategy might focus much less on the BA's operational emissions and much more on the larger contributors to the overall Broads emission. Though we in no way suggest that the BA should consider adopting an offsetting approach in this way, there is, after all, the potential (in principle) to deliver reductions from other emissions sources (such as land use or tourism & recreation) that could even go beyond offsetting all of the current emissions from the BA's operations making the BA itself 'carbon neutral' or even in 'carbon credit'.

In practice, however, the BA:

- can do something about its own operational emissions;
- needs to 'be seen' to do something about its own emissions; and
- by doing something to tackle its own emissions the BA will be acting as a beacon for authorities and local communities where this may indirectly deliver emissions reductions much more widely.

As such, there is a balance to be struck between actions to reduce emissions at an operational scale and actions to reduce emissions at a wider scale. This was the subject of the workshop held at the BA Head Quarters on 27 January 2010 which has provided direction and additional information for this report.

On the basis of the discussions at the workshop this report considers emissions and possible actions at both scales separately and some of the wider issues that need to be considered when deciding where the balance should lie. In this way, the report is not prescriptive in its recommendations but, rather, offers a range of options, considerations and suggested starting points for consideration by the BA.

In terms of the starting points and recommendations for actions, the report seeks not only to consider what new actions could be targeted specifically at reducing emissions but also any obvious 'hooks' on which to 'hang' these actions. Here we are aware of some (but probably not all) existing actions and initiatives that could be built upon.

In addition, for a number of strategies and initiatives it is probable that the potential for GHG reductions may not have been considered. Here, for example, Programmes of Measures (PoMs) under the Water Framework Directive (WFD) (or other activities) may be targeted on improvements in water quality through improved nutrient management. However, an additional benefit of these same measures may be a reduction in N_2O GHG emissions. We believe that this is unlikely to have been considered to date. Thus possible actions for the strategy includes activities to explore the impact of existing initiatives and, where necessary, to explore some more complicated emissions in greater depth so as to identify the best practical solutions.

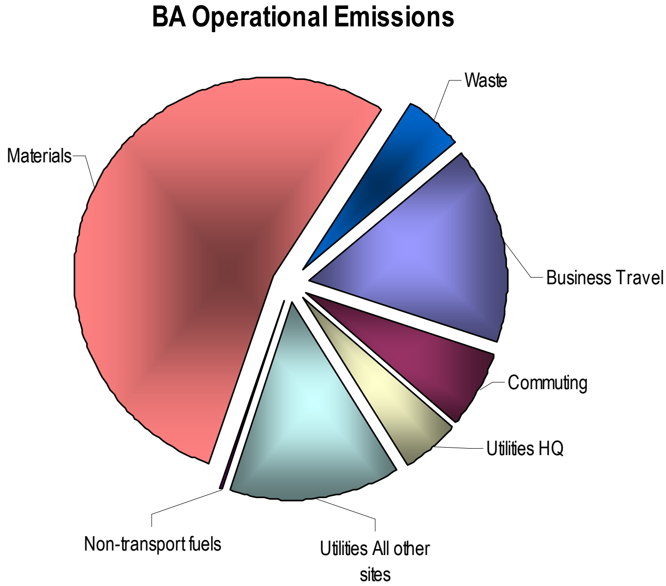
2. Emissions and Actions - the BA's Operational Emissions

2.1 Overview of Emissions – the BA's Operations

As noted above, emissions from the BA's operations only account for some 1,900 tCO_2e or ~1% of the overall emissions for Broads 'connected' emissions but there is a need for the BA to demonstrably 'put it's own house in order' as part of acting as a beacon authority.

The BA's operational emissions can be broken down into the following categories of emission:

- **Business Travel**: ~300 tCO_2e (16%);
- **Commuting**: ~120 tCO_2e (6%);
- **Utilities HQ**: ~85 tCO_2e (5%);
- **Utilities all other sites**: ~260 tCO_2e (14%);
- **Non-transport fuels**: ~7 tCO_2e (0.4%);
- **Materials**: ~1,000 tCO_2e (54%); and
- **Waste**: ~90 tCO_2e (5%).



The following sub-sections describe these emissions categories in more detail to identify the main sources of the emissions and any opportunities/targets for actions to mitigate emissions. However, before considering the specifics of individual emissions and actions as part of a strategy it is worth bearing in mind a few of the general characteristics of successful carbon/GHG reduction strategies.

Key Steps to lowering the BA's Carbon Footprint

Successfully reducing an organisation's carbon footprint involves a cyclical process comprised of the following main steps:

1. **Preparation -** this report itself constitutes a key step in preparation as it sets out what is known about emissions and their sources and, hence where priorities should lie and where data needs to be refined. In terms of the latter, better data collection strategies will strengthen confidence in the baseline data and guide and inform a process towards achieving manageable reduction targets;

2. **Development -** aim to draw together a team of interested people who will oversee the process of carbon reduction emissions, a so-called "Green Team" who can develop practical targets and disseminate this throughout the organisation. Here it must be emphasised that all staff need be engaged effectively with the strategy as delivery of the targets will involve behavioural or procedural changes on the part of staff. It is strongly recommended that staff involvement is encouraged through all

levels of the BA. Presenting the strategy as a cost effective and business critical activity will help get the message across;

3. **Targets -** to be most effective, any targets should follow the principle of being SMART (**S**pecific, **M**easurable, **A**chievable, **R**ealistic and **T**ime-bound);

4. **Implementation -** there are three main routes to carbon reduction and the most effective emissions reduction strategies will combine elements of all three of the following:

a) Technology Changes:	for example, purchasing new equipment such as duplex printers;
b) Behavioural Changes:	for example, encouraging minimal printing; and
c) Corporate Policy Changes:	for example, setting all printers to print double sided automatically.

5. **Performance Monitoring -** data collection methods need to be reviewed so that they can be most effective over a continued period of time. It should be noted that there is a balance to be struck - detail is important and necessary but at the same time too much detail can result in overly time-consuming processes which can discourage users and reduce the effectiveness of the scheme. Effective monitoring lays the foundation for convincing communication of the BA's achievements in the reduction of emissions;

Our experience in preparing this study indicates that there is a weakness in environmental data management and reporting systems within the BA at present. Owing to the relatively high number of assumptions that were needed to address data gaps, data quality for this report is judged as medium to low. As noted above, reliable monitoring and data collection is essential and, without good quality measurement, action planning is likely to be poorly focussed, meaning that target-setting may be problematic and progress is difficult to determine. Instituting more effective data gathering and monitoring processes can make the processes of gathering data both more robust and easier. In addition, it can, in itself, help to drive carbon reduction efforts because the mere existence of carbon/GHG emissions as a variable to be measured helps to raise awareness of its importance as well as providing a means to adjust policies and behaviours to enhance its reduction. Some examples of data collection measures are provided in the Box 2.1.

Box 2.1: Examples of Data Collection Measures for the BA's Operations	
Utilities	Install meters for more accurate monitoring. If this is not feasible, utilities can be recorded directly from bills but if bills for the site are not available, requests should be made for data from central offices and/or buildings manager. As regards water a simple water audit can be taken for a month and annual results estimated from that.
Materials	Procurement system to capture all units/weights purchased, ideally by make and model.
Waste	Contractor is required to provide disaggregated figures of waste collections by material type and final destination. For service premises, manual waste audits can estimate content of bins.
Commuting	Full survey of staff which needs to be completed on an annual basis.
Business travel	All travel can be booked through a central account which records distances and modes.

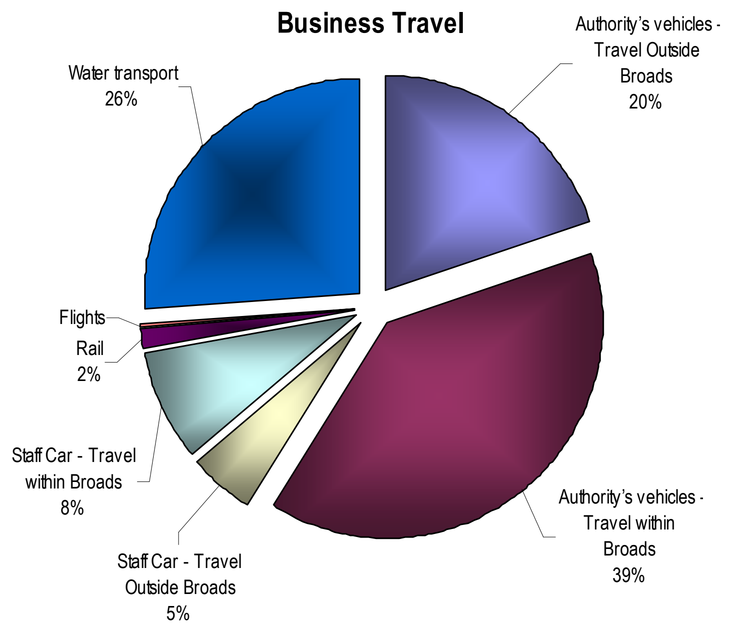
6. **Re-evaluation** - this step is crucial in a process of change with the questions needed to be asked:

    - What worked well?
    - What could have been better?
    - What are the ongoing steps to continue to do to continue reducing the GHG emissions associated with the BA?

2.2 Business Travel

The BA's business travel as a whole accounts for some 300 tCO_2e (16% of the BA's total operational emissions) and is broken down as follows:

Business Travel: ~300tCO_2e (16% of total)	Travel within Broads	Authority's vehicles	120
		Car (owned by staff or volunteers)	25
	Travel Outside Broads	Authority's vehicles	60
		Car (owned by staff or volunteers)	15
	Rail		5
	Flights		0.2
	Water transport		80



As can be seen from these data, car travel accounts for some 72% of the business travel emissions of which 59% is from BA fleet road vehicles. Emissions from BA watercraft also contribute significantly and make up some 26% of the overall emissions for business travel.

Travel by Car

In relation to road travel emissions there are three general means of achieving emissions reductions:

1. improvements in transport efficiency and use including improved logistics and reductions in the need to travel ;
2. shifting to different transport modes; and
3. changes in fuel type.

Improvements in transport efficiency and use

Securing improvements in transport efficiency and use has two key threads:

- improving the efficiency of the vehicles themselves (which will reduce the GHG intensity of any travel by car); and
- optimising the use/non use of fleet vehicles and transport arrangements as a whole.

In terms of vehicle efficiency, there are technological means available including the purchase of low(er) carbon vehicles and also behavioural means such as providing training in low emission driving techniques.

In terms of vehicle procurement, actions take longer to deliver a benefit owing to the lifetime of vehicles. However, whilst it is likely that fuel efficiency is already part of the BA's vehicle procurement policy, procurement policies might benefit from being revisited to ensure both that decisions on individual vehicles gives appropriate weight to the issue and, also, that there is sufficient consideration given to matching vehicles with vehicle use. Here, whilst it is recognised that some fleet vehicles with off-road capability may be required on occasion, there can be a tendency in some organisations to overstate the need/frequency of use for such a capability and translate this into a need for multi-purpose vehicles - i.e. 4WDs. As such, attention should be given to the extent to which the BA's fleet is populated and managed in a way that maximises the matching of the 'right vehicle with the right journey'.

With regard to the management of the BA's vehicle fleet, currently data connecting fuel use and distances travelled appears sketchy or, at best, has not been linked together. As such, estimation for this assessment was based on fuel consumed alone which, while it provides good data on actual emissions from transport, does not provide sufficient detail to allow an assessment of intensity per km travelled.

A key first step for the BA, then, is to consider how best to optimise the management of the existing fleet to ensure that greater consideration is given to the need for a given journey and, given an identified need for a journey, that the most appropriate vehicle available for that journey is used if at all possible. This needs to ensure that all travel can be booked through a central account which records distances and modes of travel (i.e. is not just restricted to the BA's fleet vehicles).

In addition to carbon savings, it is worth noting that substantial cost savings can also be delivered by this route. For example, the Department for Transport (DfT) identifies a saving of up to £90,000 per 100 vehicles each year by implementing green fleet practices. This general figure, of course, may not reflect the realities of the BA travel but does serve to demonstrate the financial as well as carbon reduction benefits of fleet management.

In terms of specific recommendations on the fleet and its management, it is worth making use of the free advice through the Energy Savings Trust (EST). The EST is funded by DfT to deliver free, independent advice to organisations to minimise carbon emissions associated with business travel. Organisations with more than 50 vehicles are eligible for a free on site Green Fleet Review by a fleet management expert. Other free advice is also available for smaller fleets[5].

Shift to a different transport mode

In relation to transport mode, given the rural nature of the Broads area, public transport (though present) is limited in coverage. Whilst there are trains (and occasional buses) linking Norwich to a few stations in the Broads, there are few means of flexible travel beyond these points.

In relation to using public transport to substitute journeys by car within the Broads (whether by fleet vehicles or other), then, opportunities are limited. However, in relation to travel outside the Broads Area there may be more opportunity to switch transport mode but this depends on the destinations involved. As already noted, the ability to book travel through a single account would help ensure a correct match between journey and mode/vehicle.

Changes in fuel type

Switching to fuels incorporating a proportion of biofuel or switching to electric vehicles are both potential technical solutions that might be considered as part of a strategy in future. However, at present, factors including the sustainability of source fuels/electricity and penetration of both vehicle and delivery technologies complicate the option at present. It may be possible in the longer term for the BA to investigate the feasibility of converting some of its organic waste streams into suitable transport fuels such as bioethanol or biogas. This approach has the added advantage of reducing the impacts of waste as well as securing a lower carbon, renewable fuel source. Presently though, it is recommended that actions in relation to fleet and travel management are taken first and options in relation to alternative fuels and drive systems are considered later.

Water Transport

Whilst road vehicle emissions dominate the business travel emissions, the BA's watercraft emissions do make up some 26% (80tCO_2e) of the overall business travel emissions.

As with fleet road vehicles, information on boat emissions is sketchy at best and, in common with road vehicles, there is a need to implement the more effective fleet management and monitoring that would allow fuel use to be connected with watercraft and associated operations. Here it does not seem unreasonable to suggest connecting the BA watercraft use with the travel account that needs to be developed for other fleet vehicles. Either way, a comparable system fleet management and monitoring appears necessary. This would allow the BA to better identify options and solutions for individual vessels where, depending on the vessels and purpose of the vessels, such options might include:

[5] see http://www.energysavingtrust.org.uk/business/Business/Transport-in-business

- use of smaller capacity auxiliary engines for normal cruising speeds (here, any mismatch between main engine capacity, vessel size/hull design and normal speeds of <6mph may result in excessive fuel consumption for normal cruising speeds - use of small auxiliaries may be a possible option);

- use of electric auxiliary motors charged from renewable sources (such as photovoltaic trickle chargers, small wind generators or other);

- attention to efficient hull shape (it is known that this is already a strong consideration in vessel procurement); and

- use second generation bio fuels - this option has been considered in the past in relation to the hire fleet on the Broads and may already be one of the solutions that the BA has examined/is examining as part of sustainable boating/tourism initiatives.

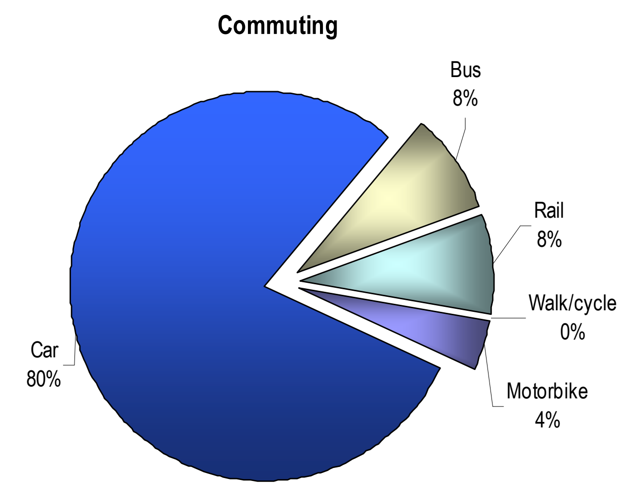
2.3 Commuting

Emissions from commuting make up 6% of total emissions of the BA's operations and can be broken down as in the figure below.

In terms of emission reduction actions, in principle, the BA could develop and implement a formal staff travel plan with incentives for staff to use the lowest carbon options where possible.

In practice, however, there is general agreement that the BA is already conscious of optimising commuting behaviour and that performance is relatively good. This, combined with the relatively small impact of the commuting component suggests that developing and implementing a staff travel plan is **NOT a priority at present** and attention should be focussed elsewhere in the short to medium term.

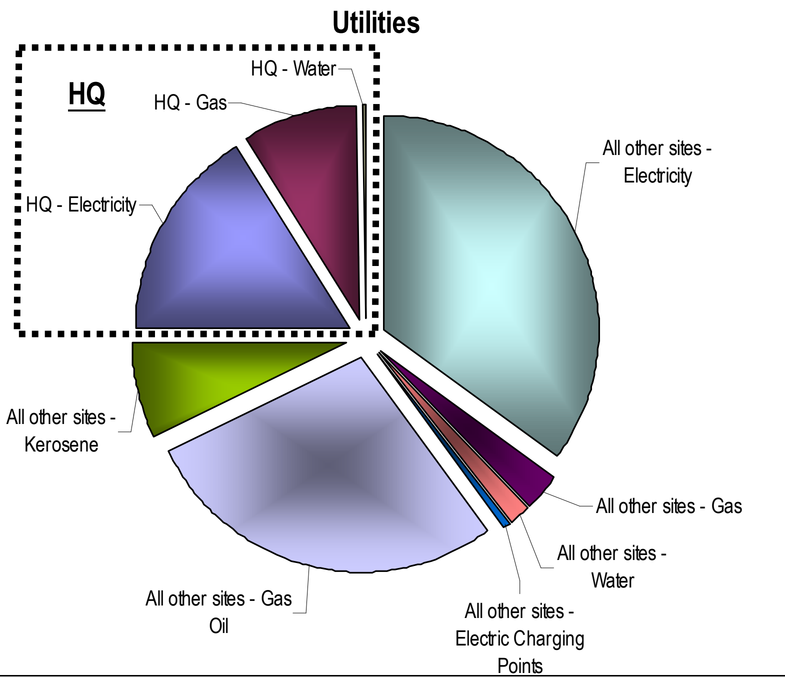
Commuting - 120t (6% of total)	Motorbike	5
	Car	95
	Bus	10
	Rail	10
	Walk/cycle	~0



2.4 Utilities

Emissions from utilities represent around 345 tCO_2e, or 19%, of the overall emission for the BA's operations. Of this, the data suggest that most of this emission (14%) is associated with utilities for sites other than HQ offices. A breakdown is provided below:

Utilities - 340t (18% of total)	Utilities HQ - 85t (5% of total)	Electricity	55
		Gas	30
		Water	0.5
	Utilities All other sites - 260t (14% of total)	Electricity	120
		Gas	10
		Water	5
		Electric Charging Points	2
		Gas Oil	95
		Kerosene	25
		Biohydran	0.1



Before discussing these in more detail it is worth noting that the audit is based on the most recent complete year's worth of data on utilities consumption and, as such, the audit does not reflect the recent move to the new Dragonfly House low carbon building but, rather, the old Colegate Offices.

This, of course, means that a number of specific carbon saving actions that might have been recommended for HQ may have already been implemented by the move. Whilst this might appear to be a weakness in the audit it does provide the opportunity to attempt some sort of comparison between utilities consumption at the two sites once a full year of data are available. Interestingly, at the workshop, a number of BA staff identified that efficiency savings did not seem to be as significant as one might have expected but, at the same time, it is difficult to screen out the BA's utilities use and efficiency from the other organisations also based in Dragonfly House (the BA was the sole occupant at Colegate). It will be worth exploring these issues in more detail once data for Dragonfly House is complete.

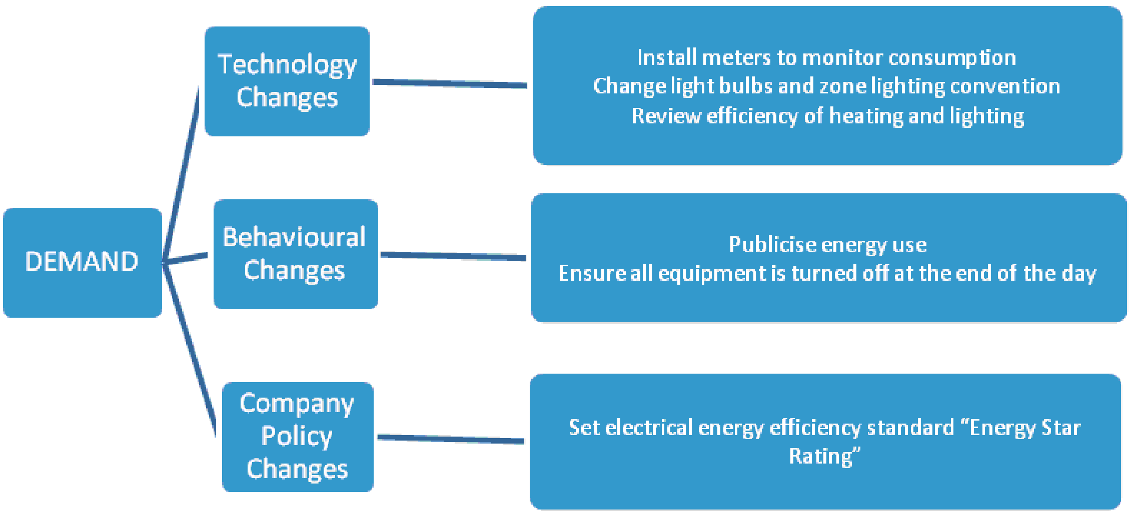
In the meantime, from the perspective of emissions reduction actions, it is worth considering utilities consumption at other sites and the potential for these to be reduced through both demand management and exploring alternative supply options. At the 'extreme' end of alternatives, there is potential to examine the usage of some of the sites (e.g. visitor centres) and consider whether these are required.

It is worth noting at the outset that a switch to so called 'Green Energy Tariffs' is often mistakenly seen as a quick fix for emissions reductions. As will be described below, in practice things are much more complicated and the identification and implementation of demand side measures is the first step. This point is reinforced by the fact that green tariffs actually represent the purchase of an emissions reduction and, as such, current (2009) Defra guidance requires the publication of two sets of values for energy consumption: a Gross Figure (total emissions from energy use) and a Net Figure (incorporating any offsets).

Demand Side

Demand side measures can be split into three main changes as in the diagram below. The following energy efficiency measures have a payback period of several years or less and are likely to provide savings in both carbon and cost:

- Energy auditing;
- Monitoring;
- Smart Metering; and
- Building Efficiency.



<u>Energy Audit</u>

A basic energy audit consists of a number of very simple steps to ensure that the basics are covered:

- monitor energy usage when the building is unoccupied and see if there are areas for immediate reductions;
- check whether a standby facility can be used on office equipment i.e. photocopiers, printers etc and make sure that staff use it;
- make sure that staff switch off lights in the office if there is sufficient daylight;

- ensure that timers are correctly set on heating/ventilation as appropriate for the occupancy of the building (in the case of the BA there may be buildings that have only seasonal use - if so consider how the building can be 'mothballed' most efficiently over winter - for example, is it possible to drain pipes that might otherwise freeze rather than heat the building over winter);
- install lighting control so that external lights should only come on when it is dark and use motion sensors to avoid unnecessary lighting.

Monitoring and Smart Metering

Monitoring power usage is an important tool in reducing energy consumption through raising awareness of where energy is being used and so encouraging energy efficiency. Energy consumption for major areas of the premises or individual processes can also be monitored on an ongoing basis. Here it is possible to install sub-metering for key processes/activities where this helps to build a profile of energy consumption, identify areas of more significant energy consumption and, as part of ongoing monitoring, allows faults to be easily noticed and repaired.

In combination (or by themselves) smart meters are capable of logging the power consumed and exporting data for collation on a computer. Consequently they can be a very useful and convenient tool for monitoring and improving energy efficiency particularly when there are a number of operational sites (as in the BA's case). Ideally data should be gathered at half hourly intervals, though relatively few organisations that use substantial amounts of electricity normally do this. Such regular records of consumption will enable priority areas for further savings to be identified and for energy usage to be monitored against shift and temperature patterns throughout the day. Accurate up-to-date records can also provide a prompt warning of any problems or changes that lead to an increase in demand.

Whilst meter installation requires some initial investment, there is usually a very swift return (usually one or two years). In our experience a better understanding of energy use can lead to savings of in the region of 5-7.5% of gas and electrical power without the need for further significant investment. Given the office share at HQ, there would be benefit in liaising with other occupants to share costs and define shared goals.

Electrical Equipment

Electrical equipment is a high user of electricity and significant contributor to emissions so it is very important to ensure that environmental criteria are used in procurement policies and development of IT. The move to Dragonfly House may mean that many of these matters may have already been considered, for example the BA is already committed to a particular IT system. However, the following are general recommendations for lowering carbon emissions from electrical equipment:

- when new equipment is purchased, choose chose energy efficient models such as those with the 'Energy Star' rating[6].

- consider switching to a 'lean client system' where all significant processing and programmes are concentrated in one central server. Not only do lean client systems consume less energy they also have other benefits including lower hardware costs, enhanced security and lower IT administration costs;

[6] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductCategory&pcw_code=OEF

- consider purchase of multi-functional devices (MFD) that combine several functions (printing, copying, faxing, scanning) in one;

- ensure that all fluorescent lamps are fitted with the most energy efficient ballasts - ballasts consume as much as 20% of the power of the lighting system; and

- where specific electrical items are integral to the functioning consider how to increase efficiency. For example, if the BA is using a IT server system, consider how this can be made more efficient.

Building Efficiency

It almost goes without saying that improving the efficiency of existing buildings can have a significant impact especially where current standards of insulation and heating systems are poor. Actions should be identified could include reviewing building insulation, heating systems and appliances. Here there are a number of resources that may be of use including:

- three software packages are available and may be of use for the implementation of Energy Performance in Buildings Directive (EPBD) for non-domestic buildings (see http://www.ukreg-accreditation.org/ND-Non-domestic.php); and

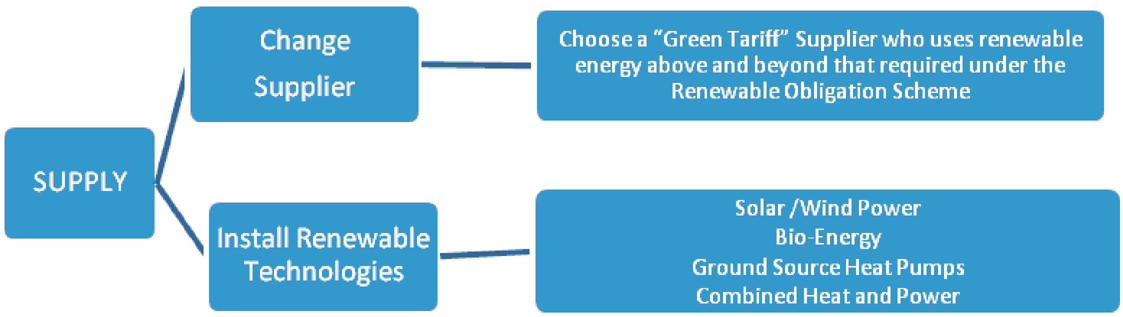
- the National Calculation Method for the EPBD (Energy Performance of Buildings Directive) provides an approved simulation software; and

- BRE's new Simplified Building Energy Model (see http://www.ncm.bre.co.uk/).

As noted earlier, a more extreme option is to consider closing a building altogether.

Supply Side

As noted above, supply side measures should only be considered once energy efficiency measures are fully implemented. The two main strands of demand side measures are outlined in the diagram below. Of the two, most attention has been given to investment in a renewable energy tariff (the so-called 'green tariff'). There are also likely to be opportunities for installation of renewable technologies even at a small scale (such as on electric charging points) but investigation of these would be a longer term goal for the BA.



Green Tariffs Explained

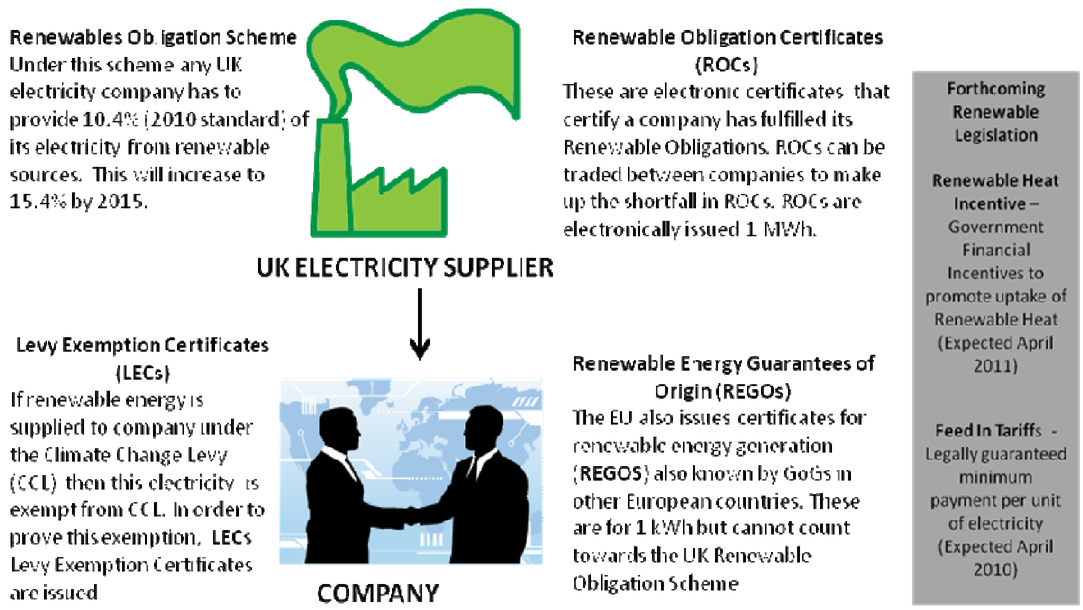
Green tariffs are electricity tariffs marketed as having environmental credentials. The market is an emerging one and following allegations of 'greenwash' and consumer confusion, Ofgem is in the process of setting up an independent certification scheme following consultation with electricity suppliers and based on findings in the Ofgem "Green Supply" guide[7]. In its guidance Ofgem argues that green tariffs should fulfil the following criteria:

- transparency;
- clear evidence of renewable supply;
- additional – contributing to additional environmental benefits than would have occurred on Business as Usual scenario such as UK Government's Renewables Obligations target;
- accredited under the Ofgem's Green Tariff Scheme (certified tariffs for the public and small businesses are now available with the launch of The Green Energy Supply Scheme[8] on 9 February 2010).

At the time of writing, no single electricity supplier emerges as the being the clear winner in providing electricity above and beyond the Government requirements. If the BA were to pursue the option (for example for HQ) it should choose a certified tariff from the Green Energy Supply certification scheme. Certified Green Tariffs are not ranked because the additional benefits are approached in different ways. For example, some Green Tariffs come from suppliers with a higher level of existing renewable generation, while others are more focused on investing in new renewables, or in energy efficiency. It is left for the customer to decide the preferable option.

The figure below provides an explanation of the legislation behind green tariffs.

The legislation behind Green Tariffs explained



Accounting for a Green Tariff in the BA's Future Footprint

If the BA were to pursue the green tariff option there is a need to provide separate accounts for energy consumed and any offsets. Here, the most recent release of Defra's Greenhouse Gas Reporting Guidelines in September 2009 advises that if a company has purchased emissions reductions there should be two figures reported.

[7] Ofgem Green Supply Guidance
http://www.ofgem.gov.uk/Sustainability/Environment/Policy/Documents1/Green%20supply%20guidelines%20final%20proposals%20open%20letter.pdf
[8] http://www.greenenergyscheme.org/

The first is a Gross Figure (total emissions from energy use) and the second is a net figure (which is the Gross Figure less any offsets).

2.5 Materials and Waste

Emissions from the materials and waste category covers:

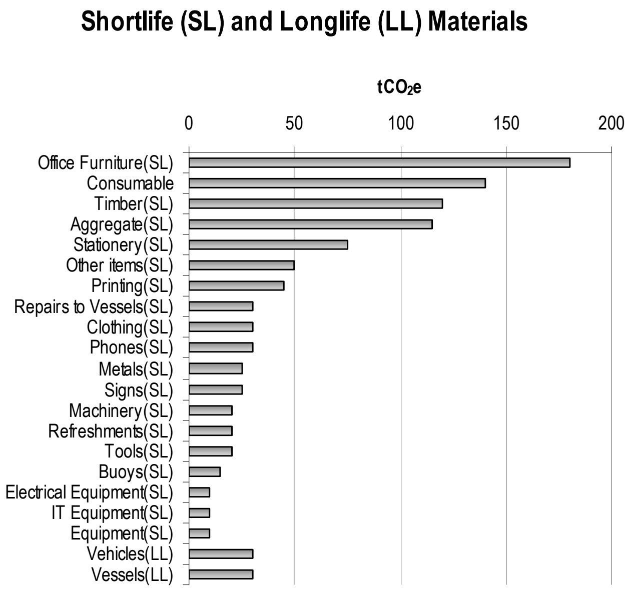
- embodied carbon in short and long-life materials (such as machinery, equipment, vehicles, etc.); and
- various waste materials.

The data from the audit suggest that emissions from materials are likely to be the largest of all of the emissions for the BA's operations with a calculated emission of around 1,000 tCO_2e, or 54% of the overall emission for the BA's operations. However, there are a number of caveats to add to this owing to the fact that the data captures the move from Colegate to the new HQ at Dragonfly House and so is expected to overestimate annual emissions. Bulk purchases in the year of the office move can also be expected to have an influence upon spending and procurement in the years to come.

In addition to these issues, owing to a lack of specific data on actual purchases, the emissions from short life materials had to be based on expenditure data (as opposed to physical data). As a result estimates of this component are of lower quality/resolution.

A breakdown of the current figures for materials (corresponding with the office move) and also waste is provided below.

Materials - 1000t (54% of total)		
Shortlife	Office Furniture	180
	Consumable materials	140
	Timber	120
	Aggregate	115
	Stationery	75
	Other items	50
	Printing	45
	Repairs to Vessels	30
	Clothing	30
	Phones	30
	Metals	25
	Signs	25
	Machinery	20
	Refreshments	20
	Tools	20
	Buoys	15
	Electrical Equipment	10
	IT Equipment	10
	Equipment	10
Longlife	Vehicles	30
	Vessels	30
Waste - 90t (5% of total)	Absorbents, IT, Oil, Rags	
	Mixed waste, to landfill	90
	Sewage waste	<1



The extent of any overestimate and subsequent effects on spending and associated emissions from the office move is obviously difficult to establish especially as there is no physical data on actual purchases that might allow some estimate of lifetime of items purchased. However, on the basis of expert judgement we would estimate that normal operations would incur emissions in the region of 20-25% for materials (in other words the actual annual emissions may be around half those estimated) and around 5-10% for waste.

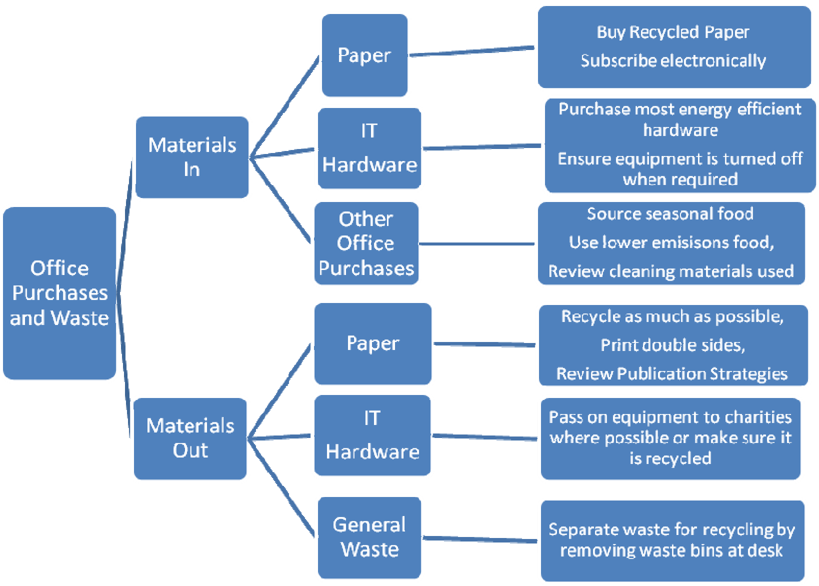
In terms of actions for the BA to consider in relation to materials and waste, there is a clear need for further development of procurement and reporting structure to address the fact that the current procedures do not make it clear what is included in which sections. While doing this, principles of sustainable procurement should be integrated into the process.

Currently the data available (in terms of descriptions and volumes) is of limited quality, with procurement seeming to be conducted by multiple individuals within the BA. Whilst such a system offers a quick process for purchasing it risks duplication and/or selection of unsuitable materials in different areas which, in turn, would make the introduction of any transparent sustainable procurement policy difficult and inconsistent. We suggest that if the BA does not wish to centralise procurement, it should at least aim to consolidate the purchasing to some extent and ensure that all buyers have a strong grasp of sustainable procurement and 'best practice'.

In terms of developing best practice systems and sustainable procurement there is specific guidance available from both Procuraplus and the Office of Government Commerce (OGC) and the BA is referred to this more detailed guidance as follows:

- The Procura+ Manual: provides clear, easy-to-understand guidance for any public authority on how to implement sustainable procurement in practice - no matter what size or level of experience (see http://www.procuraplus.org/index.php?id=4611); and
- OGC guidance on the procurement process (see http://www.ogc.gov.uk/policy_and_standards_framework_how_to_buy.asp and http://www.ogc.gov.uk/procurement_documents_best_practice_guidance_.asp).

Generalised actions to reduce carbon under the heading of materials and waste are provided in the figure below.



In terms of waste specifically, as with short-term materials, mixed waste breakdown is unknown and, for the estimates, office waste breakdown has been assumed and, in addition, waste skips and drums have been assumed to have been full.

A full waste audit could help to obtain better data quality as well as identifying opportunities for increasing rate of recycling rate in waste disposal. At the same time, emissions from waste appear to represent only around 5% of the overall carbon emissions and these emissions are not of the highest priority. As such, it may be better to wait until waste disposal contracts come up for renewal and require the waste contractor to provide disaggregated figures of waste collections by material type and final destination or, alternatively, explore whether this arrangement could be brought forward.

3. Emissions and Actions - Wider Emissions 'Connected with' the Broads

3.1 Overview of Emissions – Wider Sources

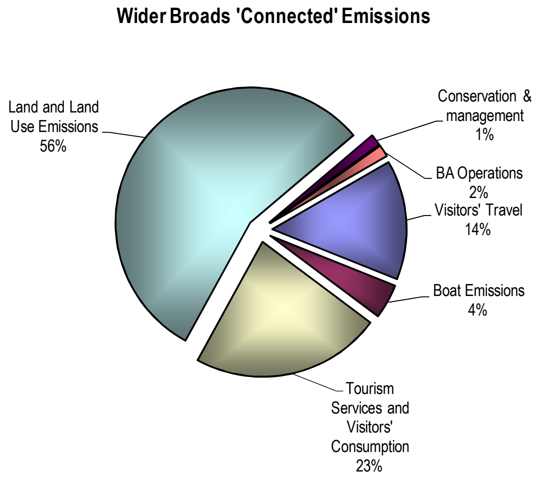
As well as being able to implement actions to reduce its own operational emissions, by virtue of its duties and powers, the BA has the potential to influence a number of wider (and much larger) emissions in the Broads. These have been loosely defined as being those most connected with the Broads but this also stretches to emissions from the only major industrial emitter in the Broads, namely Cantley Sugar beet factory.

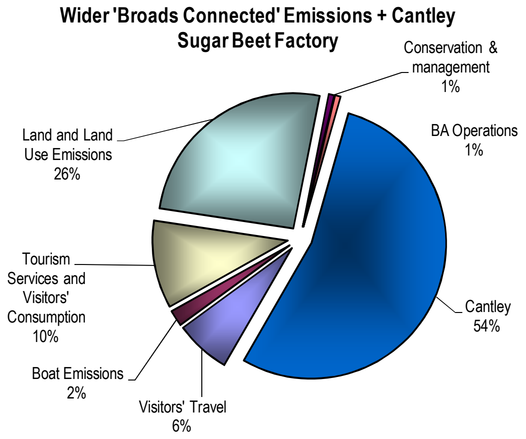
As was identified in Section 1, there is a balance to be struck between efforts to reduce the BA's own operational emissions and efforts to reduce emissions in the Broads more widely. In principle at least, even a fairly small percentage reduction in some of the wider emissions is likely to achieve a much larger actual reduction in emissions than can be achieved at an operational level. Indeed, the potential exists in theory to offset residual the BA operational emissions completely by actions in the wider Broads Area, making the BA 'carbon neutral' or even in 'carbon credit'.

Table 3.1 provides an overview of the emissions and stored carbon.

Table 3.1: Overview of wider emissions	
Category	**Emissions tCO_2e**
Emissions	
Visitors' Travel	18,920
Boat Emissions	5,500
Tourism Services and Visitors' Consumption	30,000
Land and Land Use Emissions	73,500
Conservation & management	1,850
The BA's Operations (addressed in Section C2)	1,900
TOTAL	**131,500**
Cantley Sugar beet Factory	154,000
Stored carbon	
Vegetation Stored Carbon	1,057,000
Soil Stored Carbon	38,827,000

Viewed graphically the pie charts below show the relative magnitude of the emissions with and without the inclusion of Cantley in the overall total. The remainder of this section unpacks these emissions categories and seeks to identify the next steps for action to reduce emissions at each level.

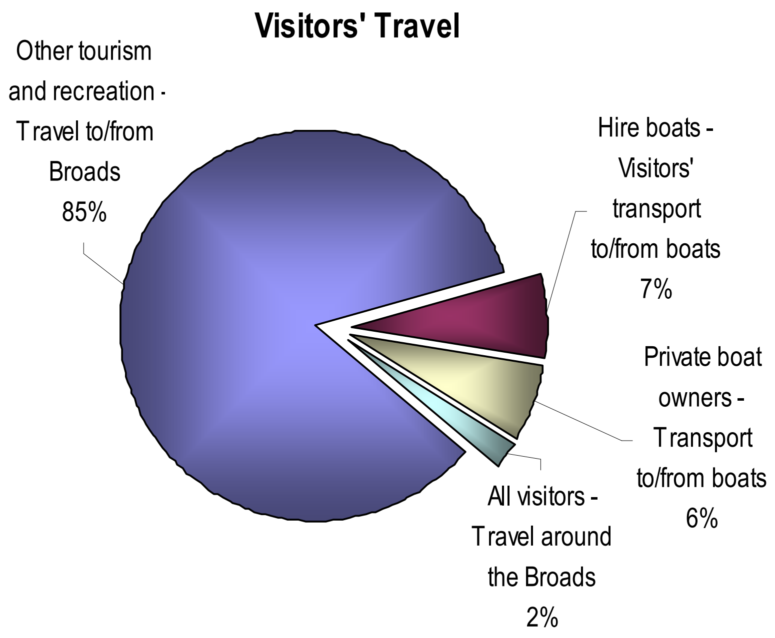




3.2 Tourism and Recreation - Visitors' Transport

Visitors' transport emissions have been estimated from a combination of BA tourism data and assumptions on the frequency of boat use on the Broads. Emissions from each are summarised below.

Visitor's Transport – 18,920t (14% of total)	Other tourism and recreation - Travel to/from Broads	16,000
	Hire boats - Visitors' transport to/from boats	1,300
	Private boat owners - Transport to/from boats	1,200
	All visitors - Travel around the Broads	420



The estimates suggest that 98% of the transport emissions are associated with journeys to and from the Broads as opposed to transport around the Broads. Within this, most of the trips to/from the Broads are not associated with visits to boats/boat hire but, rather, for other tourism and recreational purposes.

Clearly, influencing the major constituent of the emissions (journeys to/from the Broads) is perhaps difficult or, more particularly, the impacts of doing so in terms of level of emissions reduction would be difficult to measure. However, there are a few options that might be considered as part of a wider sustainable tourism strategy.

Journeys to/from the Broads

In terms of journeys to/from the Broads there are three main mechanisms by which one could produce a reduction in emissions namely, influencing driver behaviour, increasing the number of visits by public transport, and providing the means to use a sustainable biofuel mix.

Suggested BA actions/options under each of these headings are provided in Box 3.1.

Box 3.11: Preliminary Suggestions for BA Actions on Transport to/from the Broads	
Influencing driver behaviour	Journeys by car to the Broads are, at least for the foreseeable future, likely to be the dominant means of travel. A means of reducing the intensity of these journeys might be to encourage more fuel efficient driving behaviour in visitors by means of both information as part of a sustainable tourism leaflet supplemented by a pledge system that could be embedded in the BA website or hosted separately (see for example the CRed System[9]). The pledge system could both provide a means to gauge impact and also could also be used for a range of other pledges in relation to the sustainable tourism strategy. An information/pledge system of this kind would be most easily communicated to travel connected with more formal or organised recreation such as boating but also, with partners such as the wildlife trust/RSPB, to bird watching and similar environmental tourism. More general leaflet information at Broads centres or signboards might help communicate the message more widely.
Increasing the number of visits by public transport	Increasing the number of visits by public transport could be achieved by the same means as the above (driver behaviour) and also by increasing the awareness and existence of routes to and within the Broads. In the case of overnight stays, of course, there will be more tendency to travel by car owing to holidaymakers need to carry cases and fishing equipment but often there may be a perceived need on the part of the overnight tourist to bring large quantities of food and other supplies. Here, working with the hire boat federation and other tourism organisations, the BA might seek to encourage accessibility to local services (or even online supermarkets such as Tesco) and the putting together of food packages for visitors. The success of such a venture is, in part, dependant upon provision of local transport services (described later). In terms of day trippers, in combination with increasing accessibility and connectivity of public transport and cycling within the Broads (discussed below) greater marketing of connections by train might be considered and information provided.
Providing the means to use a sustainable biofuel mix	A technological option could include increasing access to sustainable biofuel mixes by encouraging garage forecourts in the Broads to make such fuels available. This may at least impact on emissions from the return journey for longer distance visitors. When considering this, links to the possibility of bioethanol produced from Cantley might be explored.

Travel within the Broads

In terms of travel within the Broads, many of the actions suggested above will also have an impact upon travel within the Broads. In addition, some of the suggestions outlined above are also partly influenced by accessibility to travel within the Broads.

In terms of BA actions in relation to transport within the Broads there are two main threads to any approach. The first is to increase accessibility to (and coverage of) public transport routes such as buses. Increasing cycling is also something that will reduce emissions and this is already part of the BA's strategy in relation to sustainable tourism and the Broads. The 'Broadshopper' bus service is an example of an existing effort to achieve both. It is not clear whether the service (which takes both passengers and cycles) is still running or whether expanding what service exists is feasible. Whichever, increasing the number of tourists arriving by public transport is likely to

[9] http://www.cred-uk.org/RegistrationStage1.aspx

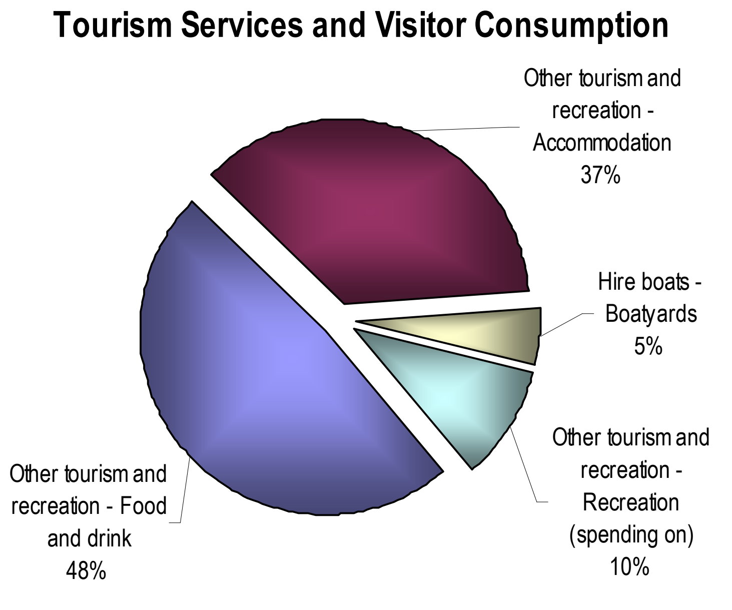
increase the viability of buses. It is suggested that the status and possibilities should be explored further as an action.

The second is to increase the connectivity of various places within the Broads. This, of course, includes number/frequency of buses and routes but also extends to small river crossings such as foot/bicycle ferries. Only a few of the original small ferries of this kind are still in existence and a rekindling of some or all of these would permit the development of circular cycle paths/walks that cross rivers and allow the visitor to get around much more easily and, it is noted, if these are restricted to foot/cycle ferries (as opposed to car ferries), would provide an additional incentive to leave the car at home. It is believed that there is already a Broads SDF project that is examining the re-establishment of a ferry on the Broads and a number projects have established cycle routes.

3.3 Tourism and Recreation - Tourism Services and Visitor Consumption

Estimates of emissions from tourism services and visitor consumption are by no means precise but are likely to be of the order of 30,000 tCO_2e. A breakdown of the emissions is provided below.

Tourism and Recreation Services – 30,000t (23% of total)	Other tourism and recreation - Food and drink	14,500
	Other tourism and recreation - Accommodation	11,000
	Hire boats - Boatyards	1,500
	Other tourism and recreation - Recreation (spending on)	3,000



The largest component of the emissions is associated with general services to the tourist comprising accommodation and food and drink. As with the travel emissions, these emissions clearly demonstrate the importance of multiple emitters and, as such, delivering even a small percentage reduction for each of these will produce a large reduction of emissions in total.

The BA already has a Green Business Tourism Scheme to develop and promote green hotels and restaurants. In addition it was suggested at the workshop that it may be possible to 'bolt on' a green tag to the existing restaurant review guide to promote low carbon tourism. The BA has a database of restaurants and could use this to communicate to businesses.

When considering what actions to encourage within such a scheme it is important to be aware that actions such as 'locally sourced food' are relatively weak. The hospitality sector is often a relatively high emissions source and this is generally closely linked to energy use and high throughput of materials. As such, the BA should be wary of the 'traditional' good practice for hospitality sector which tend to be focussed on softer issues such as local food and recycling, rather than harder carbon centred actions such as energy efficiency.

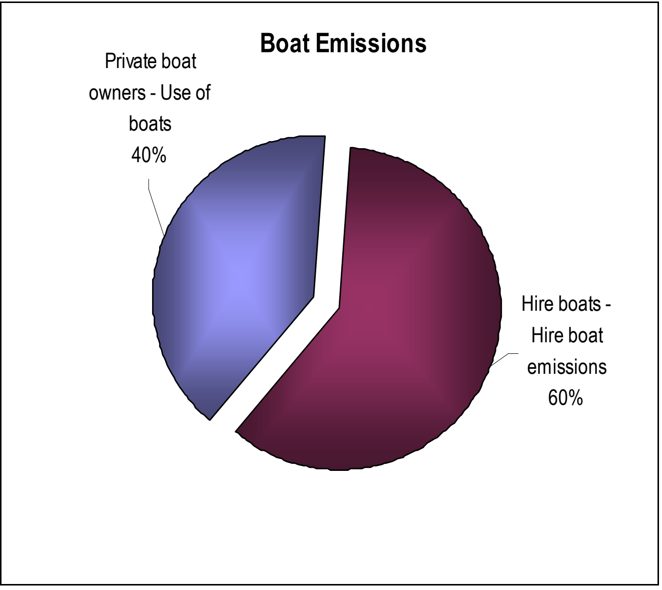
Here, then, actions oriented specifically towards energy efficiency should be encouraged where here, again, a pledge system (such as that suggested for transport and sustainable tourism) might be a useful way of both engaging and monitoring the effectiveness of the strategy.

3.4 Tourism and Recreation - Emissions from Boats

Emissions from boats comprise emissions from both private and hire boats. Emissions from private boats has been estimated assuming an agreed range of values concerning frequency and duration of boat use (tied to the visitors' travel emission) and typical estimated motoring hours for each boat type. Emissions from hire boats have been drawn from a detailed study of the Broads hire fleet undertaken by Helen Colyer on behalf of the Broads Hire Boat Federation (BHBF)[10].

Total emissions are estimated as being of the order of 5,500 tCO_2e (the equivalent of around 5% of the overall emission for Broads connected emissions) and are broken down as follows:

Boat Emissions – 5,500t (4% of total)	
Private boat owners - Use of boats	2,200
Hire boats - Hire boat emissions	3,300



In both cases (hire and private) it is interesting to note that emissions from use of boats appears to be around double the emissions from transport to/from boats (estimated earlier as 1,300 and 1,200 tCO_2e for travel to hire and private boats respectively).

The abovementioned BHBF study identified a number of conclusions and recommendations in relation to reducing emissions from the hire boat fleet. These are considered briefly below in relation to both private and hire boats:

[10] A Carbon Audit of the Broads Hire Boat Industry. Helen Colyer, 2008

Biodiesel

When produced from recycled oils and used as an alternative to fossil diesel oil could produce fairly significant overall savings in carbon emissions if used across the entire fleet. A full trial of biodiesel, produced from recycled frying oil, was performed by 28 boats from seven selected yards on the Broads between May 2005 and Autumn 2007. The trial report concluded that there are significant operational and environmental benefits attached to the use of the fuel but that there are a number of technical and supply difficulties that need to be overcome. These include:

- some yards experienced problems from waxing of filters or mobilisation of pre-existing dirt which caused them to cease the trial; and

- there were major concerns at the cost of the fuel and the reliability of supply. Biodiesel can be produced quite cheaply if a source of recycled oil is readily available, but commercial sources of reliable biodiesel, at the volumes required are not easily found.

In terms of cost, the price differential will have changed since the report as the derogation on 'red diesel' was removed in November 2008. As such, the potential for biofuel use on Broads boats may have changed and it may be worth revisiting the issue as part of action to reduce carbon emissions.

Bioethanol

The BHBF study identified that the use of bioethanol as a fuel should not be considered an environmentally sustainable option for reasons of biodiversity, soil erosion and alternative land uses associated with bioethanol derived from sugarcane in Brazil or corn in the USA.

While this is correct, it may be worth exploring the status and environmental costs and benefits of using the more local supplies of bioethanol from existing sugar beet factories. For example British Sugar opened a Bioethanol plant in Wissington, Norfolk, in 2007.

Electric conversion

The BHBF study identified that expansion of the use of electric day boats in preference to diesel powered boats could produce a reduction in emissions from the hire boat fleet. This conclusion was made on the basis that CO_2 emissions from an electric boat are about one third that of a diesel boat so a switch to fully electric hire fleet would save about 184 tonnes CO_2 p.a. or 6% of the hire fleet emissions.

While this may be a fair conclusion, as with all electrically powered vehicles, carbon emissions are highly dependent on the electricity supply used and the appropriate design and use of motors. Electricity consumption on electric boats appears to depend critically on throttle used for propulsion and appropriate size of motor to boat size/hull shape. Whilst the difference in emissions between the (relatively large) diesel engines in hire boats and electric equivalents may be relatively significant, this difference may be much smaller when compared to smaller outboard of the kind often used on private boats. Thus, while electric conversion may, generally, produce a net reduction in emissions the benefits will vary from boat to boat and use to use.

Given this it seems sensible to suggest that electric charging points may be a candidate for a switch to a 'green tariff' (as described in Section 2.4) or, better, the possibility of combining 'green tariff' charging points with renewable energy solutions (located either on/near charging points in the form of 'trickle chargers' supplemented by 'green tariff' mains supply or by renewable energy project in the Broads). An initial conversation with a photovoltaic (PV) panel installer suggested that it would be technically feasible to construct a charging station powered primarily by PV with back-up support from an alternative source. This would most likely require a battery storage facility involving the construction of a storage shed of some kind. The roof could be covered in PV panels. These are actions that could be explored further by the BA.

In addition, in order to support further there may be a need to expand the number of shore connections and this is a further area for the BA to explore.

Fuel efficiency

Vessel speed is already limited to a maximum of 5-6 mph on the Broads to reduce bank erosion and ensure safety of boat users. This also has the effect of limiting fuel consumption.

To help ensure that boat users are aware of the speed warning lights/sounds can be fitted to boats to warn when users are likely to be exceeding limits. The BHBF report identifies that these have already been fitted by one hire boatyard. It may be worth considering whether this could be rolled out to other yards.

In combination with speed, boat hull profiles have a big impact on fuel consumption (and wash). The BA has been working to increase awareness of this for a number of years. However, inevitably, penetration of more efficient hulls into the fleet takes time owing to the relatively long lifetime of boats. There are, however, behavioural changes that can help ensure efficiency. These include ensuring that boat fenders are not left to drag in the water. This, and other messages, could be incorporated into a Broads pledge system (as described earlier).

Engine Size/Propulsion System

In terms of private boats, by far the largest component of emissions is the category 'Motor Boats' (as opposed to auxiliary yachts, day boats, and outboard powered dinghies). In all of scenarios used the category of motor boats is estimated to be responsible for around 95% of the total emissions from all private boats.

There are a number of reasons for this where this includes:

Engine Size	Petrol Average Horsepower (HP)		Diesel Average Horsepower
	Outboard	Inboard	Inboard
Aux Yacht	5.3	6.4	8.4
Day Boat	27.1	97.3	22.6
Motor	72.8	137.2	83.1
O/B Dinghy	7.7	-	-

- Engine size: as can be seen from the inset table, the power rating of motor boats is very much larger than for other boat types. This, in part, reflects the fact these vessels are larger. However, in a number of cases it also perhaps reflects a mismatch between the boats and their use. With speed limits of 5-6mph a large proportion of these vessels are likely to be significantly overpowered and consuming large quantities of fuel unnecessarily;

- Frequency of engine use: as the sole form of propulsion, motor boats (whether large or small) run engines for longer than auxiliary (sailing) yachts; and

- **Boat population:** with 5,487 boats 'Motor Boats' make up around 75% of the private boat population with internal combustion engine propulsion.

In terms of actions to reduce emissions, then, the obvious options would appear to be:

- reducing the extent to which vessels are overpowered; and/or
- increasing uptake of other propulsion (switching to auxiliary sailing yachts or electric).

Both are likely to be difficult to achieve retrospectively. In terms of the former, around 65% of 'motor boats' have inboard engines and so are difficult/unlikely to be replaced. That said, uptake of smaller outboards (of appropriate power rating) as auxiliary engines may be a partial solution or, of course, electric inboard auxiliaries. In the case of the 35% that are outboard driven replacement is technically simple but costly (unless a new engine is required anyway).

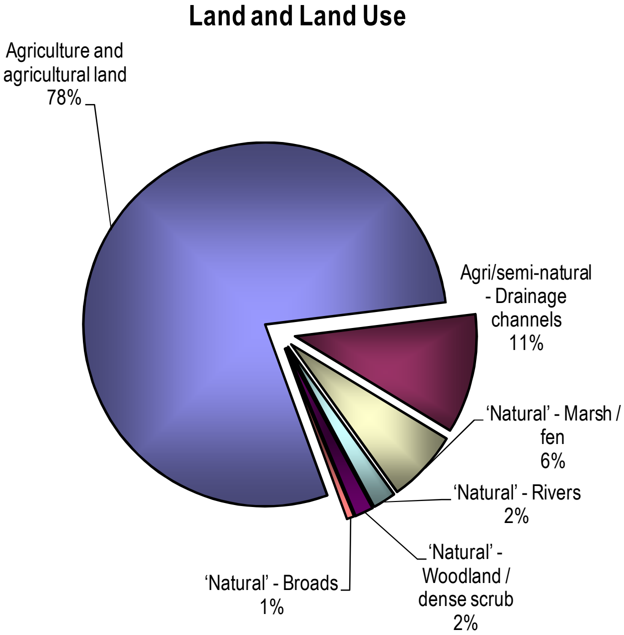
In terms of addressing the issue in future, it is possible that one reason why boats are overpowered at present is because there is a lack of awareness from buyers that such large engines, while required at sea, are unlikely to be required on the Broads. As with hull profiles, this is likely to be a difficult issue to address but may be worth further consideration/examination.

In terms of the second option (switching to sail/electric), this is a longer term option that applies equally to the hire boat and the private boat fleet. Electric conversion has been discussed above. In the case of auxiliary (sailing) yachts there may be obstacles in terms of the need to encourage/train people to sail as well as motor but this could be part of a wider package to increase uptake of sailing.

3.5 Land and Land Use – Land Use Emissions

Natural and agricultural land use emissions have been estimated for three GHGs (CO_2 N_2O, and CH_4). These emissions account for some 73,500t CO_2e which is equivalent to around 56% of the total of emissions connected with the Broads. Around 75% of the total emission from land use is associated with N_2O (which has a global warming potential of some 310 times that of CO_2). Just over 60% of the total emission is as a result of N_2O of largely agricultural origin, making targeting of N_2O in general, and N_2O from agriculture in particular, the obvious candidate for emissions reduction.

Land Use Emissions – 73,500t (56% of total)		**of which N_2O**
Agriculture and agricultural land	57,700	37,900
Agri/semi-natural - Drainage channels	7,800	7,800
'Natural' - Marsh / fen	4,700	4,700
'Natural' - Rivers	1,500	1,500
'Natural' - Woodland / dense scrub	1,200	1,200
'Natural' – Broads	500	500



In terms of means to reduce agri-land GHG emissions, an effective strategy would benefit from input and steer from a range of conservation organisations, government agencies and land owners/managers. At the BA workshop, Sarah Dawkins (Natural England) highlighted the fact that many local land owners/managers are already attuned to the threat of climate change and engaged to the prospects of low carbon agriculture through initiatives such as the Natural England's Sustainable Development programme and the Land Management Advisory Service, including ventures such as the Carbon Champions scheme. During the BA workshop Andrea Kelly (BA) also noted that UK National Parks are already taking positive steps in the agricultural sector in the form of:

- engagement, awareness & knowledge transfer with the agricultural community;
- promoting low carbon technologies, such as anaerobic digestion;
- developing programmes in conjunction with organisations such as the Farming and Wildlife Advice Group (FWAG) and helping demonstrate applications like the Country Land and Business Association's Carbon Accounting for Land Managers (CALM) tool.

As outlined in the government's "Low Carbon Transition Plan" white paper, Defra now requires the agricultural sector to develop an industry action plan to reduce agricultural GHG emissions by 3 million tonnes CO_2e per year by the third Carbon Budget period (2018-2022). It is suggested that an effective agri-land strategy for the Broads would benefit from focusing on methane (CH_4) and nitrous oxide (N_2O) emissions as, on a tonne per tonne basis, they exhibit a global warming potential, and therefore potency, 21 and 310 times (respectively) that of CO_2, and thus developing suitable protocols for their wide-scale reduction across the Broads would prove an efficient and effective approach.

This could include initiatives to develop best-practice policies to encourage landowners/managers to take up new schemes and that advocate practices that may involve reducing nitrogen fertiliser loadings, encouraging the use of anaerobic digestion and minimum tillage agriculture, incorporating organic matter to soils, and promoting organic farming, as well as taking marginal land out of cultivation.

As highlighted during the workshop, it would be sensible for the BA to strengthen its links to agencies including Natural England (which has identified that it will use its influence on land use and management to help deliver climate change mitigation). By working with partners such as Natural England, the BA could effectively engage with a greater proportion of local farmers/landowners to promote better land management and initiate a more focused agri-land climate change mitigation campaign to help implement a range of management options to reduce GHG emissions. Potential avenues for collaboration include championing initiatives promoting detailed GHG accounting of agricultural operations, such as the soon to be revised Carbon Accounting for Land Managers (CALM) tool (which now incorporates the Environmental Stewardship programme), and promoting bioenergy through the Energy Crops Scheme.

Taking a more focused view, however, N_2O is a significant component of the agri-land GHG emissions and, to be able to develop a suitably reliable reduction strategy would require more focused research because N_2O emissions are complex spatially and temporally. They are also inherently linked to diffuse pollution from agriculture and the artificial drainage of land. In relation to the former, there will be initiatives that have already been (or are being) implemented as part of, for example, Programmes of Measures (POMs) under the Water Framework Directive (WFD). The BA should consider the extent to which existing efforts are already likely to contribute to reductions in GHG emissions. Emissions reductions through such routes may actually be quite significant but, to our knowledge, have not yet been estimated.

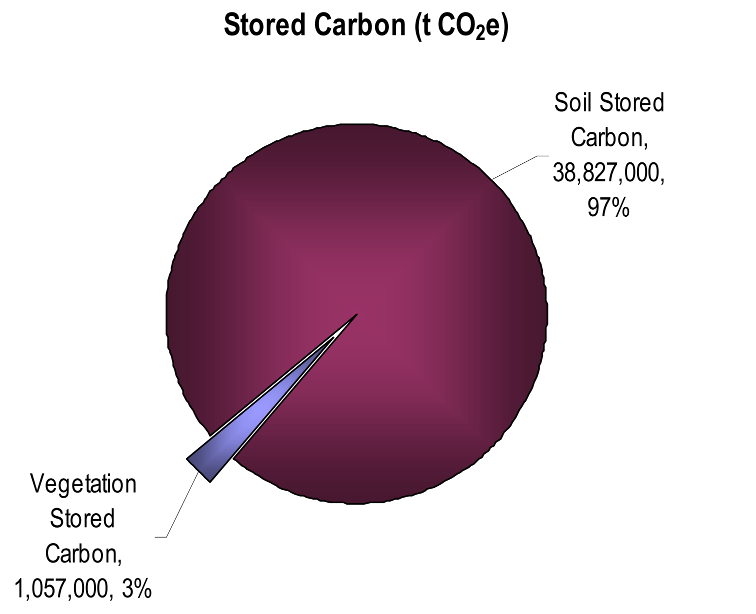
In addition to management alterations, in theory, raising water levels and taking land out of arable production would be an obvious, but perhaps controversial solution. Overall, more research is required into the relationship between nutrient management, the amount of nitrogen applied and the proportion of that which is lost to N_2O in the Broads context before any specific management options can be put forward with confidence.

Of potential interest to the BA could be the Defra-funded Demonstration Test Catchment (DTC) recently set-up in the River Wensum to monitor the effects of sustainable on-farm mitigation measures to improve water quality and river ecology as part of efforts to deliver the requirements of the WFD. Although not specifically focused on addressing GHG emissions, studies such as this have great opportunity to feed into to carbon reduction programmes, as the improvements to environmental parameters, such as water quality, are inherently linked to strategies aimed towards reducing the use of nitrogen-rich fertilisers. Thus, there is potential for the BA to work with the Wensum DTC project team to develop a range of management options that may ultimately reduce agri-land N_2O emissions. This may include, for example, initiating a PhD studentship to monitor how N_2O concentrations respond to different farm management options. The results of which could be used to develop a range of policy-relevant management options that help the Broads deliver the EU WFD by decreasing nitrogen-rich diffuse pollution, which in turn helps reduce the N_2O flux for the catchment, yet keeps arable land in production.

3.6 Land and Land Use – Carbon Stores

In addition to GHG emissions, the audit has also considered carbon stored in soils and vegetation within the Broads. The analysis suggests a total store of around 40 million t CO_2e, 97% of which is carbon stored in soils. In terms of comparison, this equates to nearly 400 years of Broads 'connected' emissions at current levels.

Vegetation Stored Carbon	1,000,000
Soil Stored Carbon	39,000,000
Total	**40,000,000**

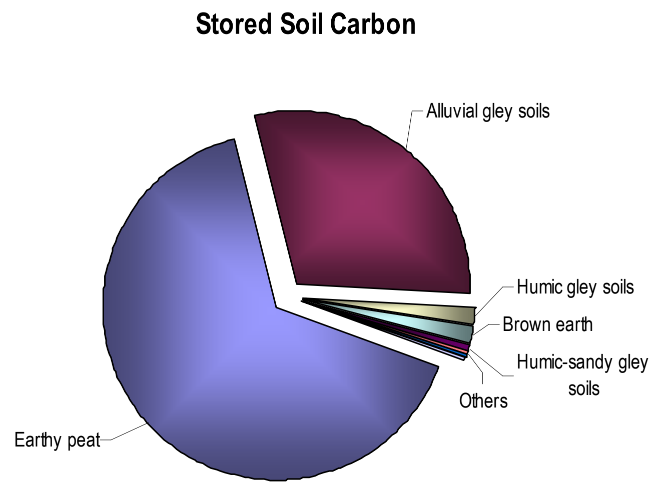


In terms of actions to conserve these carbon stores (and if possible sequester additional carbon) it is most effective to focus on the density of carbon stored in individual soil groups or vegetation classes as opposed to the overall contribution to the total as the latter also depends on area.

Soil Carbon

The estimated total stock of soil carbon is of the order of 39 million t CO_2e. The table below provides carbon stores ranked in order of the carbon density of the soil. This suggests that conservation of earthy peat soils is particularly important as these have by far the greatest carbon density and also cover a fairly large area (~9,000 ha), and consequently represent over 65% of the total carbon stored in the Broads soils. In contrast, Alluvial gley soils, whilst also important, represent a high store of carbon by virtue of their relative abundance (~17,000 ha) rather than their high carbon density.

Abiotic environment (Soils)	Stored CO_2e (tCO_2e)	As % of Total	C Density (t CO_2e ha^{-1})
Earthy peat	25,356,468	65.3%	2,808
Humic gley soils	639,453	1.6%	1,030
Humic-sandy gley soils	197,450	0.5%	742
Alluvial gley soils	11,619,295	29.9%	683
Calcareous pelosols	141,113	0.4%	533
Brown earth	616,436	1.6%	469
Stagnogley soils	19,304	0.0%	449
Agrillic brown earths	153,780	0.4%	368
Brown sand	59,721	0.2%	305
Soils Total	**38,803,020**		



Soil carbon is a common currency that underpins the management of land-based ecological function, whether the desired outcome is climate change mitigation, water quality, wetland integrity/function, or agricultural productivity and sustainability (Kimble *et al,* 2007). In their review of carbon losses from soils and its consequences for land-use management, Dawson & Smith (2007) provide a useful overview of the ability to which soils are able to sequester carbon under a range of different land use/ management regimes. They concluded there are two main methods to increase the carbon stored in soils:

- implementing "best practice" land management strategies to help preserve and optimise the existing carbon store; and
- initiating land use change to promote a step-like enhancement in carbon storage.

<u>Preserving and Optimising Carbon Storage in Soils – Promoting Best Practice</u>

Soil carbon storage can be optimised by instigating a range of "best practice" land management proposals (e.g. sustainable forestry, reduction of intensity of tillage on croplands, prevention of drainage on peatlands) to help preserve the carbon already present (Dawson & Smith, 2007). Although a change in land management to increase carbon sequestration may only result in a limited, relatively short-term response to the reduction of CO_2 in the atmosphere, a well managed, conserved soil, irrespective of land use brings about many additional benefits, including increased productivity, resilience from erosion and enhanced biodiversity and ecosystem performance. Dawson & Smith (2007) provided a detailed summary of the range of possible land management options that could be implemented to enhance soil carbon storage and sequestration. Box 3.1 describes a number of small and large-scale measures that might be considered while deriving "best practice guidelines". These could be incorporated in an engagement and knowledge transfer programme with agencies such as Natural England.

Box 3.1: Land management options to increase soil carbon stores	
Land use	**Best-Practice Options**
Croplands	Convert marginal cropland to native vegetation, grasslands or forestry; improve crop production and erosion control; improve management of set-aside and field margins; improve farming on eroded soils, erosion control buffer strips, riparian filters; reduced or no tillage; improved residue management; eliminate bare fallow; organic amendments, increased efficiency of animal manure, sewage sludge and composting; inter-sowing and increased duration of grass-leys; improved crop rotations; use perennial crops; use deeper rooting crops; use bioenergy crops; improve water and nutrient (fertilizer) management; increase number of agro-forestry systems; do not use highly organic soils for cropping.
Grasslands	Convert cultivated lands to well managed permanent grasslands, species selection; decrease erosion and degradation; eliminate disturbance e.g. fire protection in established pastures; increase forage production by improved fertilization, irrigation, inter-sowing of grasses and legumes; improve grazing and livestock management with controlled light-to-moderate stocking density; moderately intensify nutrient-poor permanent grasslands; introduce earthworms, improve soil structure; maintain a diverse plant community with a dense rooting system.
Forestry	Forest and Water Guidelines by the Forestry Commission, 'best practice' guidelines; increase forest stock; continuous cover forestry to encourage natural regeneration; conserve soil and water resources; improve site preparation and planting techniques to decrease erosion; streamside management with uncultivated buffer zones to stabilize soil and reduce acidification; design of forest roads and network of drains, culverts and sediment catch pits; reduce disturbances from wind and fire; minimise soil and water impacts and reduce clear felling operations to phased felling techniques; minimise nitrate leaching, enhance base cation retention by early re-vegetation; use species with high NPP or increase number of actively sequestering younger forests; application of nutrients and micronutrients as fertilizers or bio-solids; aesthetic planting of previously native trees and shrubs, enhance biodiversity; maintenance of open bog and moorland habitats; extension of guidelines to include conservation, landscape and recreation; plant trees on mineral soils in preference to highly organic soils.

Enhancing Carbon Storage Potential and Sequestration in Soils – Fen Restoration

Increasing carbon storage in typical agricultural soils holds limited potential, especially considering the potential extent to which food production may be displaced. Thus, emphasis would be better placed on the preservation and enhancement of the carbon-rich fen peat soils which, due to their high carbon density, represent the single greatest store of carbon and hold the greatest potential to enhance the sequestration of atmospheric carbon.

Mechanisms increasing soil carbon losses from carbon-rich peat soils are instigated by land management practices, including drainage for forestry and agricultural conversion, high water abstraction rates, grazing, vegetation removal and peat harvesting (Dawson & Smith, 2007). The drainage and disturbance of waterlogged peat soils, such as the earthy peat types present in the Broads, is likely to have contributed to significant soil carbon losses as the enhanced level of oxygenation experienced in response to water table drawdown will have caused a critical shift in the balance between the accumulation and degradation of organic matter, and the ultimate release of carbon in both atmospheric (CO_2) and fluvial (dissolved and particulate organic carbon) forms.

In contrast, it has been shown that the restoration and preservation of wetlands can be beneficial on many levels, including enhancing carbon storage potential; mitigating CO_2 emissions; improving water quality; attenuating floodwaters; reducing topsoil erosion;

and providing a critical habitat to support and promote biodiversity. Many practices can be implemented today with a net economic benefit to stakeholders, including:

- enhancing the protection and ultimate restoration of wetland soils by reducing the level of drainage and by blocking a suitable proportion of drainage ditches,
- reducing the level of mechanical disturbance, cultivation and extraction;
- controlled/reduced burning, re-vegetating bare surfaces and taking actions to promote re-colonisation, so as to prevent wind and water erosion; and
- rehabilitating acidified surface waters;

However, there is ultimately a risk that the CO_2 emission reductions following peatland restoration may be counter-balanced by enhanced production of methane and nitrous oxide. Although, there is currently little UK data with which to quantify this trade-off, it is generally considered that restoration will deliver a net GHG benefit due to the scale of the CO_2 savings, but clearly more research is required.

As regards prioritising areas for future research targeted at soils preservation and restoration, Annex A highlights the variance in soil carbon stores by virtue of carbon density within the Broads Executive area. From this, it is possible to identify that the carbon-rich earthy peat soils are primarily located towards the western outskirts of the Broads, in the "upper" reaches of the five principal river catchments. It is these areas, in particular, that would benefit from a scoping study supplemented by a field campaign to evaluate the peat resource and associated GHG emissions, and the potential to implement a restoration strategy similar to that recently conducted for the Great Fen Project[11].

Vegetation stored carbon

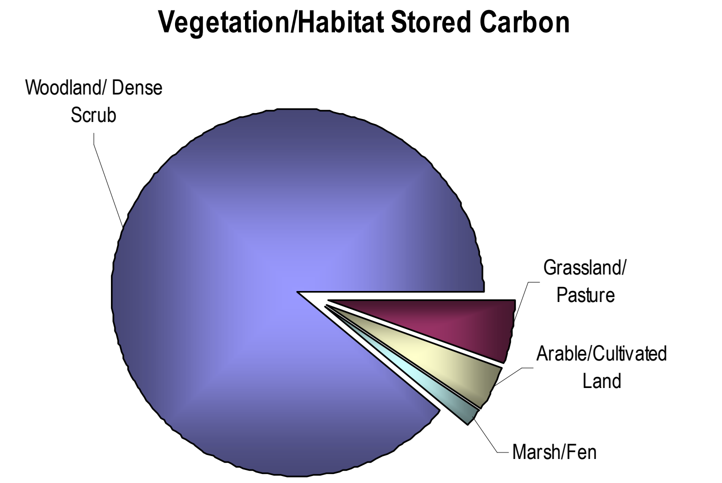
Vegetation in the Broads stores in excess of 1 million tonnes of CO_2. In the case of the habitats presented, the vast majority of carbon (89%) is stored in woodlands/dense scrub, primarily due to this type of vegetation having a very high carbon density, but also because it covers a relatively large area (>4,000 ha). This habitat comprises both broadleaved and coniferous woodland land classes and, in fact, with total carbon stored of around 930,000 tCO_2e, almost all of the carbon is stored in broadleaved/mixed woodland.

Many of the actions relating to the conservation and development of soils and habitats tend to overlap with those aimed towards reducing emissions from such environments. Here, in particular, the preservation of Broads vegetation and the fate of any harvested biomass will be important as the data suggests that, for example, the cutting, removal and burning of a hectare of woodland may release emissions in the region of ~224 t CO_2e, whilst the burning and removal of fen biomass releases about 7 t CO_2e. Thus, it is clear that careful consideration and creative management is required to safeguard these important terrestrial carbon reserves, and to minimise the GHG impact of any habitat clearance programmes (discussed in the following section).

Biotic environment (Habitats)	Stored CO_2e (tCO_2e)	As % of Total	C Density (t CO_2e ha^{-1})
Woodland/Dense Scrub	936,234	88.9%	224
Marsh/Fen	17,384	1.6%	7
Arable/Cultivated Land	43,416	4.1%	5
Grassland/Pasture	56,660	5.4%	4

[11] Gauci, V., (2008) *Carbon Balance and Offset Potential of the Great Fen Project*. Report funded by the East of England Development Agency for the Great Fen Project.

Habitats Total	**1,053,694**		



<u>Enhancing Carbon Storage and Sequestration in Vegetation – Managed Woodlands</u>

With regard to the preservation and enhancement of carbon stored in vegetation, the land use with the highest potential for carbon sequestration - woodland and afforestation - is easily one of the most cost-effective measures to slow the increase of atmospheric CO_2 and promote the development of a relatively stable and long-lived terrestrial store. However, afforestation may often be at odds with distinctive and valued landscape characteristics in the Broads and, indeed, some measures in relation to soil conservation discussed above. In terms of the latter, for example, any drainage associated with land preparation, especially in waterlogged peat soils, is likely to result in large carbon losses. Thus, afforestation should preferentially occur on shallow organic or mineral soils, and the management on the peat-rich fens should be focused on re-vegetating bare surfaces and promoting the critical environmental conditions required for the re-colonisation and development of native fenland vegetation.

The dynamics of tree growth mean that any relatively small increase in the rate of new woodland creation would have limited *initial* impact on carbon sequestration (Thompson, 2008). However, the many co-benefits associated with woodland creation make it a potentially attractive option for GHG abatement in appropriate locations. Further, there is potential to incorporate a certain percentage of species suitable for short rotation coppice (SRC) and bioenergy crops. Further research is required and the issue would benefit from a scoping study to investigate the potential of sensitive afforestation in the Broads as a means to sequester carbon.

In terms of targeting areas for conservation, Annex A provides maps of vegetation carbon density within the Broads Executive area. This suggests that the carbon-rich broad-leaved woodlands tend to dominate the “upper” reaches of the Ant, Bure and Yare Catchments.

3.7 Land and Land Use – Conservation and Other Management

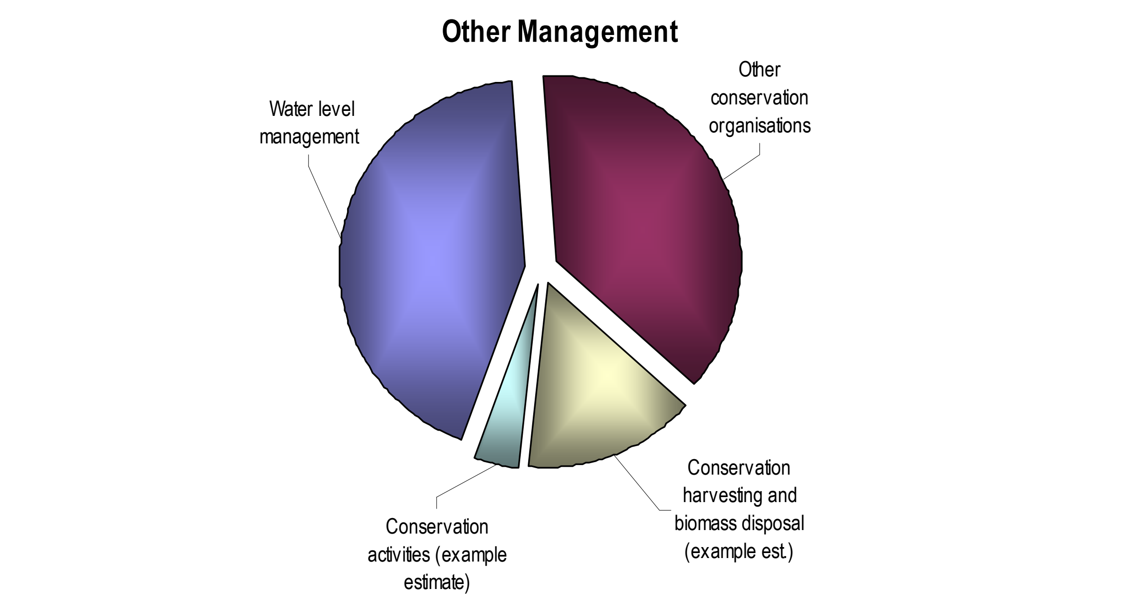
In relation to the management aspects of conservation and land use, it has been difficult to provide a full catalogue of all activities and emissions. Conservation management works are carried out by a number of different actors in the Broads where this includes the BA but also includes other conservation organisations, conservation volunteers, farmers, contractors and others. As such, developing an aggregate estimate of emissions in the Broads Area as a whole is particularly challenging not least because of not knowing what activities take place, covering what areas, using what methods and how frequently they occur. An additional complexity is that fuel and transport emissions associated with the BA conservation work are already accounted for in the assessment of the BA operational emissions considered in Section 2. As such, the emissions associated with, say, chainsaws or boats, are embedded within the more general data (and are not amenable to being separated out from that data).

In the light of the issues associated with deriving an estimate of the aggregate emissions, then, this section considers a few examples of the more significant and widespread activities/emissions with a view to identifying opportunities and actions to reduce emissions. Approximate emissions are provided in the table below for:

- potential scale of emissions from other conservation organisations' work in the Broads;
- fen harvesting, illustrating the importance of considering the fate of harvested material in the emission's and efficiency savings equation as well as direct emissions from carrying out activities; and
- water level management on the Broads.

The remainder of this section briefly considers key actions in relation to reducing emissions across management activities.

Conservation and other management – 1,850t CO_2e (1% of total)	
Water level management	800
Other conservation organisations	700
Conservation harvesting and biomass disposal (example est.)	280
Conservation activities (example estimate)	70



Role of Engagement with other Organisations and Appraisal

In relation to emissions from conservation management activities, as noted above, there are many activities and actors. As such, the focus of any of the BA's actions needs to be on two aspects:

1. improving the GHG efficiency of management activities/works carried out by the BA and also contractors, volunteers and others acting on its behalf; and

2. engaging and joining together with partner organisations on both the ethos and content of a 'whole Broads' strategy in relation to GHGs (including implementing actions under the above (1).

In terms of the first, improving the efficiency (and reducing the GHG intensity) of activities requires that one analyses the activities in some detail in order to identify areas for improvement. Given the variation in activities, the actions that are likely to be most effective in each case will depend on the individual circumstances and conditions. As such, the best approach may be to institute a 'self appraisal' process that highlights the key parts of the operation where emissions are likely to be highest followed by consideration of whether it is possible to alter the operation slightly to reduce emissions.

Importantly, such appraisal need not necessarily focus on the minutiae of emissions associated with every aspect of the activity but, rather, on identifying where obvious efficiency improvements can be made relatively easily. While such an approach can be used on a case by basis, it can also be applied to common activities in the form of general guidance. Here, then, the BA should appraise and embed carbon reduction into the 24 existing Environmental Standard Operating Procedures that already exist. Importantly, as many conservation activities involve harvesting biomass, this needs to take into consideration the issues raised below concerning disposal of biomass as well as issues in relation to those identified earlier for land use emissions including stored carbon.

As well as applying such an appraisal to its own operations and standard operating procedures, the BA could also institute such an appraisal into its dealings with contractors (for example, dredging contractors). Here, then, it is suggested that the BA should make appraisal of emissions part of the contract bidding/awarding process.

In terms of the second action (engaging and joining with partner organisations), it would be sensible to build upon the wider audit approach developed in this report and seek wider 'buy in' to the ethos and actions to reduce GHGs. In the conservation management context, clearly the main partners are the other conservation organisations (such as Norfolk Wildlife Trust) that could adopt (and may already be adopting) audit and appraisal of emissions for operations. Partnering in this way not only maximises the efficiency savings within the Broads and takes them further afield, but also allows the distribution and sharing of efforts to identify alternative options and procedures. Partnering, however, should not be limited to conservation organisations but should extend to other organisations/individuals with an impact on emissions (whether associated with conservation or other emissions category such as tourism or boating).

Update/Re-assess Options for Disposal of Harvested Biomass

As noted above in relation to the need to institute appraisal, a large number of conservation related activities involve the 'harvesting' of biomass and the fate of that biomass needs to we worked into considerations of GHG efficiency of operations alongside appraisal of points of direct emissions.

The fen management example provided in Box 3.2 below provides a good illustrative example of this issue and illustrates that the potential emissions from the biomass can be several times (or even several orders of magnitude) higher than the direct emissions from carrying out the activity.

Box 3.2: Fen Management Example

The BA uses several different land management techniques to restore and conserve the fens, which includes scrub clearance, fen harvesting and reed and sedge cutting. The BA undertook its own carbon audit[12] of land management techniques in 2006, which evaluated emissions generated from the direct usage of fossil fuels for the different land management activities (mainly from the machinery used for digging, cutting, chopping and shredding, and for transportation of the machinery and cut material) and indirect energy used in inputs (such as energy used in the construction of machinery). Based on this 2006 work, the direct GHG emissions associated with the management of the Broads fens are given in the table below:

Direct (non-biomass) GHG Emissions associated with fen conservation			
	Area (ha)	**CO_2 Emissions (t CO_2e)**	**CO_2 Emissions per ha (t CO_2e/ha)**
Conservation cutting	6	3.03	0.51
Fen harvester	12	13.16	1.10
Commercial reed and sedge cutting	79	3.17	0.04
Rotating scrub clearance	14	51.86	3.70
Total	**111**	**71.22**	

As can be seen from the table, considering only the more direct emissions associated with fen management suggests a total emission of 71 t CO_2e for annual clearance of 111ha. As is also clear from

[12] Olloqui (2006)

the table, the scale of emissions per ha of clearance varies significantly from one method to another where this illustrates the trade-off between GHG emissions and other objectives. Here, while emissions are higher for the fen harvester it is known that this has a lower 'ecological' footprint as far as disturbance to fenland habitats is concerned.

In terms of GHG emissions, analysis of the direct carbon emissions of fen harvesting and scrub clearance would suggest relatively small GHG emissions and relatively little scope for making significant cuts in emissions given other conservation priorities. Once the fate of biomass is considered as well, however, this situation changes.

Here, based on the 111 ha of fen managed on an annual basis, and applying data sourced from the literature[13] on the approximate mass of vegetation harvested per ha (1.56 t ha^{-1}) a total annual yield of 173t of harvested biomass is derived from the operations. Applying this mass of biomass to emissions data suggests that, depending on the end-use/fate of the material, the GHG emissions generated from harvested biomass might range from 138 t CO_2e (landfill with gas flaring) to 284 t CO_2e (natural decay/burning) or up to 1,090 t CO_2e (landfill with no flaring of methane). In other words, the potential emissions from the biomass are several times (or even several orders of magnitude) higher than the direct emissions from carrying out the activity.

Given that other conservation management activities also often involve the harvesting of biomass (such as woodland management and weed cutting), the same is likely to apply for other conservation management activities whether undertaken by the BA or by other conservation organisations.. As such, when appraising methods and emissions from carrying out activities so as to identify the means of delivering emissions reductions, the first place to start may, in fact, often be to consider the fate of harvested biomass rather than (relatively) small changes in the way in which the management activities are carried out.

Here, when considering the optimal fate for biomass from an emissions perspective, one should be focussed on:

- 'locking' the carbon in the biomass away for the longest time possible while seeking to limit the production of decomposition by products such as methane and nitrous oxide; and/or

- making use of the energy from burning as part of a renewable energy project (perhaps combined with technologies such as the production of biochar that lock a proportion of the carbon away).

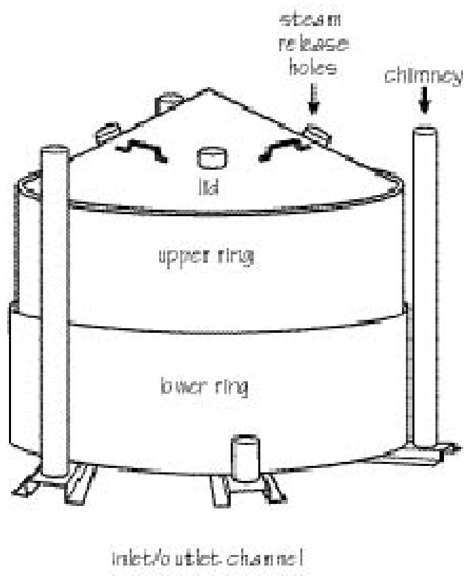
When considering the fate of biomass it should be noted that there are 'low tech' solutions that might be applied as well as 'high tech'. It is known that the BA has, in the past, considered the 'high tech' (for example, conducting a scoping study in 2002 to investigate the potential for bioenergy) but it may not have considered the possibility of applying 'low tech' options.

It is recommended that further investigation is carried out into the various options for the disposal of the various types of biomass (using both high and low tech approaches). A few examples of options for dry/woody biomass are provided below. As part of general consideration of biomass disposal it may also be worth considering disposal options for wet biomass (such as water weed). Here it seems likely that wet biomass may be a source of N_2O that has not been accounted for in this assessment and this might be (relatively) easy to reduce/eliminate.

[13] Broads Authority, 2004b; Sanderson and Prendergast, 2002

Low Tech Options

In terms of the low tech, options depend on the type of biomass. For wood, it may be worth considering the use of portable metal ring kilns to convert wood into charcoal and, thus, retain at least some of the carbon that would otherwise be emitted. Typically portable kils of this type comprise a bottomless steel cylinder, with a removable lid, chimneys and air inlet/outlet channels (see inset). BTCV (amongst others) have information on such small scale portable charcoal kilns (see for example, http://handbooks.btcv.org.uk/handbooks/content/section/3768). BTCV report that, in British woodland conditions, a rule of thumb is that about half a tonne of charcoal will be produced from 3 tonnes of wood (around 7.5 m^3 of air dried wood) in a double ring kiln (7'6"-8' diameter), equivalent to a 16% yield. Whilst this is not a high rate of yield it may, at least from a carbon management perspective, be preferable to open air burning.



High(er) Tech Options

As noted above, in 2002 the BA conducted a scoping study to investigate the potential for bioenergy. This scoping study concluded that the operation of a Biomass Energy Plant would be outside the specialisation of the expertise of the Broads Authority, but that fuel supply and operation issues could be overcome by awarding an operating contract to a third party.

As the market and available technologies have developed significantly over the past 8 years, it may be worth re-evaluating the options available in an attempt to at least secure a more sustainable end use for the biomass and, as part of this, to consider the production of Biochar as a means to sequester atmospheric carbon and offset the BA GHG emissions.

In principle there is the possibility that harvested biomass (from both the BA management and conservation partners) could be used as a renewable fuel for a biomass energy system located locally within the Broads. Fen vegetation in general (and reed in particular) has a calorific value (dry matter basis) similar to wood. There is also the opportunity to bulk up the fen biomass by combining it with other locally occurring biomass materials, such as wood, straw or other crop residues in order to operate a larger, more robust, bioenergy production system. The proposed ecotown at Rackheath has as part of its energy supply infrastructure a biomass power station. Similarly, the proposed Norwich Power House development also plans to use biomass as part of its feedstock. Though neither of these developments have received planning permission it is not unthinkable that either, both or another similar biomass power development would be able to take advantage of the BA's biomass waste streams.

It is possible to provide a rough estimate of the potential carbon savings associated with the use of the fen biomass as a potential generator of renewable bioenergy. Firstly, the likely mass of fen vegetation harvested on a per hectare basis is about 1.56

t ha^{-1} and using a choice of areas that could be managed[14] for this purpose, the total annual mass of biomass that could be produced ranges between 173t and 1,596t.

For every tonne of biomass used approximately 0.76 tonne of coal and 475 m^3 of natural gas can be displaced. In turn, each tonne of coal displaced prevents approximately 2.3 t CO_2 being released and each cubic metre of natural gas displaced saves 2 kg CO_2[15]. Thus, the displacement of coal or gas could potentially avoid between 164 and 2,790 tonnes of CO_2 per annum depending on the yield of harvest.

On the basis of the current average "annual harvest" of biomass (111 ha) alone, the displacement of coal would save 304 t CO_2 (16% of current the BA operational emissions) whilst the displacement of gas would save 164 t CO_2 (~9% of the BA's operations). Clearly, with an increase in harvested area (and/or working in partnership with other conservation partners) the magnitude of savings through displacement increases.

If a biomass gasification combined heat and power (CHP) system was utilised, which operates at ≥80% efficiency, there is also the potential to generate a carbon-rich by-product (biochar), which could be used for long-term sequestration in soils (Collison *et al*, 2008). A typical biomass gasification system generates between 3 and 10% of its input yield as Biochar, suggesting that the Broads could potentially generate between 5 and 48 tonnes of Biochar per annum at a 3% yield, and 17 and 160 tonnes at 10%. As Biochar typically consists of ≥65% carbon this equates to a minimal sequestration potential of between 12 and 382 t CO_2. The University of East Anglia is commissioning such a plant which is creating a lot of interest in the renewable energy field. In time other similar plants may well be developed in the area.

Water Level Management

The Broads Area is at considerable theoretical risk of river flooding and inundation from the sea. The actual risk is substantially reduced by the work of the Internal Drainage Boards (IDBs) that, working in partnership with Local Authorities, the Environment Agency and Natural England, monitor and manage water levels, in simple terms, by means of level gauges and pumps.

The Broads IDB operates 34 pumping stations all of which are electric. Owing to the need to keep costs to a minimum, during 'normal' conditions (between low and high settings) these pumps are programmed to run at night on lower tariffs. Whilst it is difficult to attribute actual carbon savings, the practice of running pumps overnight is consistent with reducing grid demand in peak hours and, thus, is consistent with efforts to reduce carbon.

In terms of opportunities to reduce emissions, smart metering is already being applied. However, emissions from electricity consumption are quite significant. A complementary pumping option is the use of direct pumping by wind. Whilst wind pumps will never offer a 'drop in' substitute for the high pump volume electric pumps, according to the Broads IDB, wind is an option and is very effective and efficient for 'trickle' pumping when combined with backup from electric pumps with greater volumes. Indeed, the Broads IDB recently installed a wind pump (servicing Calthorpe Broad) which pumps up to a reservoir and a second stage pump (also wind) draws from the reservoir and is run by Natural England.

[14] Sourced from: Broads Authority, (2004b) and Olloqui (2006)
[15] Sourced from Defra: http://www.defra.gov.uk/environment/business/reporting/conversion-factors.htm

The Broads IDB predicts a trend towards management within smaller catchments over time as there is a need to provide varying water levels at smaller spatial scales. Wind trickle pumps provide a good means of achieving this and so could be considered alongside upcoming decision making concerning the replacement of pumps installed in 1970's (pump lifetime is typically 50 years). It is suggested that the BA should support such considerations as appropriate.

During the study we identified some interest in the use of solar photovoltaics (PV) for powering remote sites. The Environment Agency use this technology for powering small lock gates and other monitoring points. In combination with wind this approach appears to offer quite reliable power supplies and is worthy of further investigation.

3.8 Other Emissions – Domestic and Industry

As is noted in Section 1, this audit has focussed on those sources of emissions that the BA has most power to influence and, to this end, the main focus has been on emissions 'connected with' the Broads and the 'services' it provides. As such, while wider emissions from, domestic, local transport and industrial sources have been estimated for the purposes of comparison, they are, in the main, outside the principle focus of interest for a strategy, though the BA might consider partnering with key local authorities to support their efforts in carbon reduction from these sources.

As identified in Section 2.1, however, one possible exception to this is the emissions from Cantley Sugar Beet factory. Cantley lies within the boundaries of the BA executive area and, at around 154,000 tonnes CO_2 per annum, estimated emissions are significant. As such, the BA should encourage and assist Cantley to curb emissions as much as is possible.

4. Summary of Actions and Next Steps

This section summarises actions that could be applied to reduce emissions at both the level of the BA's operational emissions and wider emissions in the Broads. Recommendations are not prescriptive but, rather, offer a range of options, considerations and suggested starting points for the BA. For each action a timescale/priority is indicated as short (S), medium (M) and long term (L).

Emissions and Actions - The BA's Operational Emissions ~1,900 tCO_2e

General Comments

There is a lack of environmental data management and reporting systems within the BA at present.

Reliable monitoring and data collection is essential and, without good quality measurement, action planning is likely to be poorly focussed, meaning that target-setting may be problematic and progress is difficult to determine. The actions recommended here relate to both more effective strategies for data collection as well as actions towards emissions reduction.

Business Car Travel ~220 tCO_2e

Improvements in transport efficiency and use

Procurement policies may benefit from being revisited to ensure that decisions on individual vehicles gives appropriate weight to fuel efficiency and low carbon transport and that decisions on the fleet as a whole provides a sufficient pool to match vehicles with vehicle uses as much as possible (e.g. avoiding the use of off-road vehicles for road journeys as much as possible). **S/M**

Data connecting fuel use and distances travelled appears sketchy or, at best, has not been linked together. A key first step for the BA is to consider how best to optimise the management and use of the existing fleet and transport as a whole to ensure that greater consideration is given to the need for a given journey, the most appropriate mode of transport is used and, where a car is needed, that the most appropriate vehicle for the journey is used where possible.

It is suggested that business travel as a whole should be organised in such a way that all travel can be booked through a central account which records distances and modes of travel. In addition to carbon savings, it is worth noting that substantial cost savings can also be delivered by this route. **S**

The first step may be to explore the availability of free advice through the Energy Savings Trust (EST). Organisations with more than 50 vehicles are eligible for a free on site Green Fleet Review by a fleet management expert. Other free advice is also available for smaller fleets[16].

[16] see http://www.energysavingtrust.org.uk/business/Business/Transport-in-business

Changes in fuel type

It is recommended that actions in relation to fleet and travel management are taken before options in relation to alternative fuels and drive systems. Efficient functioning of the system is the priority whatever the fuel used.

M/L

Water Transport ~80 tCO_2e

Information on the BA's boat emissions is also sketchy and, in common with road vehicles, there is a need to implement the more effective fleet management and monitoring that would allow fuel use to be connected with watercraft and associated operations.

It is suggested that the BA's watercraft use could be connected with the central travel account as this would allow the BA to better identify options and solutions for individual vessels.

S/M

Commuting ~120 tCO_2e

There is general agreement that the BA's performance is relatively good and developing/implementing a staff travel plan is **NOT a priority at present**.

M/L

That said, an annual full survey of staff should be instituted and completed on an annual basis. This will allow more effective monitoring and the ability to identify trends and solutions that might be considered I the future.

S

Utilities ~340 tCO_2e

HQ ~85 tCO_2e

It should be noted that the audit has been based on the most recent complete year's worth of data on utilities consumption and, as such, the audit does not reflect the recent move to Dragonfly House (which has been designed with high efficiency in mind).

Whilst not ideal, this does provide the opportunity to attempt some sort of comparison between utilities consumption at the two sites once a full year of data are available and also determine what further improvements might be made in HQ.

M

Other Sites ~260 tCO_2e

It is worth considering utilities consumption at other sites and potential for these to be reduced through both demand management and exploring alternative supply options. Some actions will also be applicable to HQ.

Undertake a Simple Energy Audit

The BA should undertake a simple energy audit of buildings. This should begin by following a few simple steps to ensure that the basics are covered. These steps include:

S/M

- monitor energy usage when the building is unoccupied and see if there are areas

for immediate reductions;
- check whether a standby facility can be used on office equipment i.e. photocopiers, printers etc. and make sure that staff use it;
- make sure that staff switch off lights in the office if there is sufficient daylight;
- ensure that timers are correctly set on heating/ventilation as appropriate for the occupancy of the building (in the case of seasonal buildings, how these can be 'mothballed' most efficiently over winter);
- install lighting control so that external lights should only come on when it is dark and use motion sensors to avoid unnecessary lighting.

Monitoring and Smart Metering

Consider installing sub-metering for key processes/activities where this helps to build a profile of energy consumption, identify areas of more significant energy consumption and, as part of ongoing monitoring, allows faults to be easily noticed and repaired. **S/M**

Given the office share at HQ, there would be benefit to liaising with other occupants to share costs and define shared goals. These might include sub-metering the individual organisations (and parts of) and shared areas (such as reception and meeting rooms).

At all sites install smart meters capable of logging the power consumed and exporting data for collation on a computer, ideally at half hour intervals. This provides a convenient tool for monitoring and improving energy efficiency particularly when there are a number of sites.

S

It should be noted that, while these measures require some initial investment, there is a very swift return of investment (usually one or two years). In our experience a better understanding of energy use can lead to savings of in the region of 5-7.5% of gas and electrical power without the need for further significant investment.

Electrical Equipment

Electrical equipment is a high user of electricity and significant contributor to emissions so it is very important to ensure that environmental criteria are used in procurement policies and development of IT (see 'materials').

Building Efficiency

Actions to improve building efficiency should be identified. These should include reviewing building insulation, heating systems and appliances. The first step may be to see what help available from the EST and/or undertake self assessment. Here there are a number of resources that may be of use including:

- for implementation of Energy Performance in Buildings Directive (EPBD) for non-domestic buildings three software packages are available and may be of use (see http://www.ukreg-accreditation.org/ND-Non-domestic.php); and **S**
- the National Calculation Method for the EPBD (Energy Performance of Buildings Directive) provides an approved simulation software;
- BRE's new Simplified Building Energy Model (see http://www.ncm.bre.co.uk/).

At the more extreme end of alternatives, the BA could examine the use of some of the external sites and consider whether these are required at all or whether other provisions might be suitable.

Supply Side **M/L**

Supply side measures (such as switching supplier or installing renewable energy) should only be considered once energy efficiency measures are fully implemented. A switch to so called 'Green Energy Tariffs' is often mistakenly seen as a quick fix for emissions reductions. In practice things are much more complicated and the identification and implementation of demand side measures is the first step.

At the time of writing, no single electricity supplier emerges as the being the clear winner in providing electricity above and beyond the Government requirements but if the BA were to pursue the option (for example for at HQ or boat charging points – see later) it should choose a certified tariff from the Green Energy Supply certification scheme.

Materials and Waste ~1,000 tCO_2e

Data is sketchy and the estimated emissions of 1,000 tCO_2e (54% of the BA operational emissions) have been calculated using input/output analysis.

Procurement

There is a clear need for further development of procurement and reporting structure to address the fact that the current procedures do not make it clear what is included in which sections.

The BA should organise procurement centrally to ensure effective data gathering and consistent application of a procurement policy. We suggest that if the BA does not wish to centralise procurement, it should at least aim to consolidate the purchasing to some extent and ensure that all buyers have a strong grasp of sustainable procurement and 'best practice'.

The principles of sustainable procurement and best practice should be integrated into the process. There is specific guidance available from both Procuraplus and the Office of Government Commerce (OGC) and the BA is referred to this more detailed guidance for detail.

In relation to electrical equipment, the following are general recommendations for lowering carbon emissions:

S

- when new equipment is purchased, choose chose energy efficient models such as those with the 'Energy Star' rating[17].
- consider switching to a 'lean client system' where all significant processing and programmes are concentrated in one central server. Not only do lean client systems consume less energy they also have other benefits including lower hardware costs, enhanced security and lower IT administration costs;
- consider purchase of multi-functional devices (MFD) that combine several functions (printing, copying, faxing, scanning) in one;
- ensure that all fluorescent lamps are fitted with the most energy efficient ballasts - ballasts consume as much as 20% of the power of the lighting system; and
- where specific electrical items are integral to the functioning consider how to increase efficiency. For example, if the BA is using a IT server system, consider how this can be made more efficient.

[17] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductCategory&pcw_code=OEF

Waste ~90 tCO_2e

In terms of waste specifically, as with short-term materials, data on mixed waste is sketchy.

A full waste audit could help to obtain better data quality as well as identifying opportunities for increasing rate of recycling rate in waste disposal. Though emissions from waste appear to represent only around 5% of the overall carbon emissions this is an important area to consider. **M**

The BA should consider whether its waste contractor should be asked to provide disaggregated figures of waste collections by material type and final destination or, alternatively, consider requiring this when contracts are up for renewal. **S/M**

Wider Emissions 'Connected with' the Broads

~131,000 tCO_2e (adding Cantley = ~285,000 tCO_2e)

Overview of Emissions – Wider Sources

As well as being able to implement actions to reduce its own operational emissions, by virtue of its duties and powers, the BA has the potential to influence a number of wider (and much larger) emissions in the Broads.

The BA needs to strike an appropriate balance between efforts to reduce its own operational emissions and efforts to reduce emissions in the Broads more widely. Here, even a fairly small percentage reduction in some of the wider emissions is likely to achieve a much larger actual reduction in emissions than can be achieved at an operational level.

Tourism and Recreation - Visitors' Transport ~18,920 tCO_2e

The 2010 Defra vision identifies that:

- "*the pursuit of sustainable tourism is a critical objective for the Authorities*";
- *"the Authorities should promote energy efficiency within the Parks, reduce the emissions from their own operations and from those associated with visits, including through sustainable low carbon transport use"*; and
- *"promote sustainable transport, including navigation - There should be close liaison between the Authorities and local/integrated transport authorities in promoting more sustainable travel choices".*

The estimates suggest that 98% of the transport emissions are associated with journeys to and from the Broads as opposed to transport around the Broads. Within this, most of the trips to/from the Broads are not associated with visits to boats/boat hire but, rather, for other tourism and recreational purposes.

Clearly, influencing the major constituent of the emissions (journeys to/from the Broads) is perhaps difficult or, more particularly, the impacts of doing so in terms of level of emissions reduction would be difficult to measure.

Visitor Engagement / Pledge System

To help address these issues (and others) it is recommended that the BA develop an online 'pledge system'[18] to communicate actions that visitors can take to reduce emissions (and other sustainability and conservation objectives). Such pledges will help reinforce the actions, provide useful data on the uptake of those actions, and increase awareness of the BA's own commitments to reduce and manage carbon emissions and other environmental aspects.

This approach could be combined with other points of contact between the BA and visitors/recreational users (such as when sending out annual boat licence applications or information packs from boat hire companies). More formal recreational uses of the Broads will be the most easy to engage with and messages might be most easily communicated to boating but also, with partners such as the wildlife trust/RSPB, to bird watching and similar environmental tourism. General leafleting information at Broads centres or signboards might help communicate the message more widely. **S**

As noted, the pledge system could cover a range of issues as well as transport (including, for example, safety and conservation aspects of boating).

Journeys to/from the Broads

The pledge system should communicate and encourage more fuel efficient driving behaviour in visitors.

The pledge system should encourage visitors to make use of available public transport routes (and communicate information on these routes).

A longer term technological option to reduce emissions could include increasing access to sustainable biofuel mixes by encouraging garage forecourts in the Broads to make such fuels available where this may at least impact on emissions from the return journey for longer distance visitors. When considering this, links to the possibility of sustainable bioethanol produced from Cantley might also be explored. However, efficiency measures should be pursued first. **L**

Travel within the Broads

The BA should seek to increase accessibility to, coverage of and information on public transport routes in the Broads.

Further increasing cycling will reduce emissions and this is already part of the BA's strategy in relation to sustainable tourism and the Broads. The 'Broadshopper' bus service is an example of an existing effort to achieve both (but it is not clear whether it is still in existence). It is suggested that the BA should examine the status of such services and the possibilities for expansion. **M**

The BA should seek to increase the connectivity of various places within the Broads. As well as the number/frequency of buses and routes the BA should consider the possibility of foot/bicycle ferries and the development of circular cycle paths/walks. This might also provide an additional incentive for visitors to leave the car at home. It is believed that there is already a Broads SDF project that is examining the re- **M**

[18] see for example the Cred System: http://www.cred-uk.org/RegistrationStage1.aspx

establishment of one of the foot ferries on the Broads. A number cycle routes have been established.

Tourism and Recreation - Tourism Services and Visitor Consumption ~30,000 tCO_2e

The BA already has a Green Business Tourism Scheme to develop and promote green hotels and restaurants and this could be refined to encourage more robust actions.

When considering specific actions in this area, the BA should be wary of the 'traditional' good practice for hospitality sector which tends to be focussed on softer issues such as local food and recycling, rather than harder carbon centred actions such as energy efficiency. **S/M**

Actions oriented specifically towards energy efficiency should be encouraged and the BA should consider a 'bolt on' green tag to the existing restaurant review guide to promote low carbon tourism and the adoption of more targeted actions.

Tourism and Recreation - Emissions from Boats ~5,500 tCO_2e

The 2010 Defra vision makes explicit reference to navigation, noting that *"navigation can provide for various forms of sustainable transport, either through use of unpowered craft (sailing and canoes) or with innovative craft such as solar powered vessels. They can play a significant part in reducing traffic congestion and harmful emissions in local honey pot areas, and provide safe, healthy access to the Parks*".

Changes in fuel

Biodiesel

The derogation on 'red diesel' was removed in November 2008. As such, the concerns about cost raised by the 2005-07 trial of biodiesel may have now subsided/been eliminated. As a medium term action it may be worth revisiting the issue and considering whether technical and supply difficulties that were identified in the trial can also be overcome. **M**

Bioethanol

As British Sugar has been making moves towards production of bioethanol (for example by opening a bioethanol plant in Wissington, Norfolk, in 2007) it may be worth exploring future options and crossover with the Cantley factory as a medium term action. This should also consider the environmental costs and benefits of this route of supply. **M**

Electric conversion

As with all electrically powered vehicles, carbon emissions are highly dependent on the electricity supply used and the appropriate design and use of motors/vehicles. While electric conversion may, generally, produce a net reduction in emissions the benefits will vary from boat to boat and use to use.
Given this it seems sensible to suggest that electric charging points may be a candidate for a switch to a 'green tariff' or, better, the possibility of combining 'green tariff' charging points with renewable energy solutions (located either on/near charging points in the form of 'trickle chargers' supplemented by 'green tariff' mains supply or by **S/M**

renewable energy project in the Broads). These are actions that could/should be explored further by the BA. in the short to medium term. The Norfolk Car Club (http://www.norfolkcarclub.com/) is a good starting point for an investigation into options in this area,

Fuel efficiency

To help ensure that boat users are aware of speed limits, warning lights/sounds can be fitted to boats to warn when users are likely to be exceeding limits. BHBF report that these have already been fitted by one hire boatyard. It may be worth considering whether this could be rolled out to other yards as a requirement. **S/M**

Behavioural changes to promote boat efficiency (for example, ensuring that boat fenders are not left to drag in the water) should be identified and promoted within the Broads pledge system (described earlier). **S**

Engine Size

A combination of large numbers, longer motoring hours and potentially (fairly significantly) oversized engines for the vessel category 'motor boats' means that these boats are likely to be the source of 95% of the total emissions from all private boats. As a medium term action the BA could consider the extent to which it can influence future owners' choice of engine size/type (as well as hull profile) and/or encourage the use of electric or smaller output petrol/diesel auxiliary engines or even auxiliary yachts as an alternative. **L**

Land Use Emissions ~73,500 tCO_2e

In partnership with other organisations, the BA should consider how it can use/is using its influence on conservation and land management issues to:

- reduce GHG greenhouse from land and livestock management and energy use. This should pay particular attention to nutrient management and reductions in the N_2O emissions that are responsible for ~75% of land use emissions and ~40% of Broads connected emissions; and

- enhance sequestration of CO_2 from the atmosphere by carbon sinks and securing carbon stored in soils and biomass.

In conjunction with this, the BA should consider the impact of existing and proposed strategies/policies from the perspective of GHG management. More specific actions under the above are listed below:

Reducing Agri-Land GHG Emissions

Defra's 2010 vision identifies that "*Authorities should use their influence to encourage farming practices which reduce emissions, such as lower fertilizer use*".

The BA should seek to further strengthen its links with conservation organisations and government agencies, such as Natural England, to develop a more focused agri-land climate change mitigation campaign. This should aim to implement a range of management options to reduce GHG emissions and best-practice policies that encourage landowners and managers to take up new low carbon schemes and engage in initiatives such as the CALM tool and the Energy Crops Scheme. **S/M**

In terms of nutrient management, to be able to develop a suitably reliable reduction strategy more focused research is required. N_2O emissions are spatially and temporally complex. They are also inherently linked to diffuse pollution from agriculture and the artificial drainage of land. The BA should undertake some targeted research on appropriate methods and the impact of existing initiatives such as, for example, those under the heading of the Water Framework Directive (WFD). Emissions reductions through such routes may be quite significant but, as yet unaccounted for. Of potential interest here could be the Defra-funded Demonstration Test Catchment (DTC) recently set-up in the River Wensum.

S

Enhancing Carbon Storage and Sequestration in Soils

Defra's 2010 vision identifies that "*Authorities should lead the way in sustainable land management to prevent further carbon loss from soils and to encourage carbon storage in trees and fens. The deep peat soils which are out of condition should be restored*".

There are two main methods to increase the carbon stored in soils:

- initiating land use change to promote a step-like enhancement in carbon storage; and
- implementing "best practice" land management strategies to help preserve and optimise the existing carbon store.

In the short to medium term, the BA should consider the impact of its existing (and all future) strategies on soil carbon conservation. As part of this it should consider the potential role of the best practice options listed in Section 3.6 as part of a strategy to conserve and enhance soil carbon.

In terms of focus for such a strategy, as the science suggests that agricultural soils hold a limited potential to increase carbon storage, in the first instance attention should be given to preserving and restoring the carbon-rich fen peat soils. These would benefit from policies aimed at raising water levels; reducing mechanical disturbance, cultivation and extraction; controlled/reduced burning, re-vegetating bare surfaces and promoting re-colonisation; and rehabilitating acidified surface waters.

S/M

Although it is generally considered that peatland restoration will deliver a net GHG benefit due to the scale of the CO_2 savings, the BA should consider conducting a scoping study (supplemented by a field campaign) to evaluate the peat resource and associated GHG emissions and to identify the potential to implement a restoration programme similar to that conducted for the Great Fen Project.

Enhancing Carbon Storage and Sequestration in Vegetation

The Defra 2010 vision identifies that "*woodlands should be managed to increase their contribution to climate change mitigation through either sequestration in growing biomass or through wood and timber produced from the woodlands substituting for fossil fuels and more energy intensive construction materials*".

The land use in the Broads with the highest potential for carbon sequestration is woodland, and afforestation is easily one of the most cost-effective measures to slow the increase of atmospheric CO_2 and promote the development of a relatively stable and long-lived terrestrial store. As part of its wider conservation strategy, the BA should investigate the potential that afforestation and short rotation coppice could play in the Broads.

M

Conservation and Other Management >1,850 tCO_2e

Defra's 2010 vision identifies that *"park purposes cannot be achieved by any one organisation acting in isolation. Partnership working should therefore be the underpinning philosophy of all these bodies and individuals with an interest in the achievement of the Parks' purposes"*.

Conservation management works

The focus of any the BA action needs to be on:

1. improving the GHG efficiency of management activities/works carried out by the BA and also contractors, volunteers and others acting on its behalf; and

2. engaging and joining together with partner organisations on both the ethos and content of a 'whole Broads' strategy in relation to GHGs (including implementing actions under the above (1).

In terms of the first, the BA should institute a 'self appraisal' process that highlights the key parts of the operation where emissions are likely to be highest followed by consideration of whether it is possible to alter the operation slightly to reduce emissions. Such appraisal should not focus on the minutiae of emissions associated with every aspect of the activity but, rather, on identifying where obvious efficiency improvements can be made relatively easily. Importantly, as many conservation activities involve harvesting biomass, this needs to take into consideration how the biomass can be most beneficially disposed of (see below). **S/M**

As part of this, the BA should embed appraisal and carbon reduction into the 24 existing Environmental Standard Operating Procedures already in existence. **S/M**

The BA should consider building appraisal into its dealings with contractors. Here, it is suggested that the BA should make appraisal of emissions part of all contract bidding/awarding processes (whether conservation related or not). **S/M**

The BA should seek to engage conservation partners in implementing the same processes. Partnering in this way not only maximises the efficiency savings within the Broads and takes them further afield, but also allows the distribution and sharing of efforts to identify alternative options and procedures. **S**

Options for Disposal of Harvested Biomass

Emissions from harvested biomass can be several times (or even several orders of magnitude) higher than the direct emissions from carrying out conservation management activities. All activities in relation to harvested biomass should consider the optimal fate for biomass from an emissions perspective. This should focus on:

- 'locking' the carbon in the biomass away for the longest time possible while seeking to limit the production of decomposition by products such as methane and nitrous oxide; and/or

- for dry biomass, making use of the energy from burning as part of a renewable energy project (perhaps combined with technologies such as the production of Biochar that lock a proportion of the carbon away) or using lower tech solutions such as portable metal ring kilns to convert biomass into charcoal and, thus, retain at least some of the carbon that would otherwise be emitted by open air burning.

It is recommended that further investigation is carried out into the various options for the disposal of the various types of biomass (using both high and low tech approaches).

In terms of higher tech options for disposal, whilst the BA conducted a scoping study to investigate the potential for Bioenergy in 2002, as the market and available technologies have developed significantly over the past 8 years, it may be worth re-evaluating the options available and, as part of this, to consider the production of Biochar as a means to sequester atmospheric carbon and offset the BA GHG emissions.

S/M

As part of general consideration of biomass disposal it will also be worth considering disposal options for wet biomass (such as water weed) as it seems likely that wet biomass may be a source of N_2O that might be (relatively) easy to reduce/eliminate.

Water Level Management

Broads IDB predicts a trend towards management within smaller catchments over time and wind trickle pumps provide a good means of achieving this and so could be considered alongside upcoming decision making concerning the replacement of pumps installed in 1970's (pump lifetime is typically 50 years). It is suggested that the BA should support such considerations as appropriate.

S/M/L

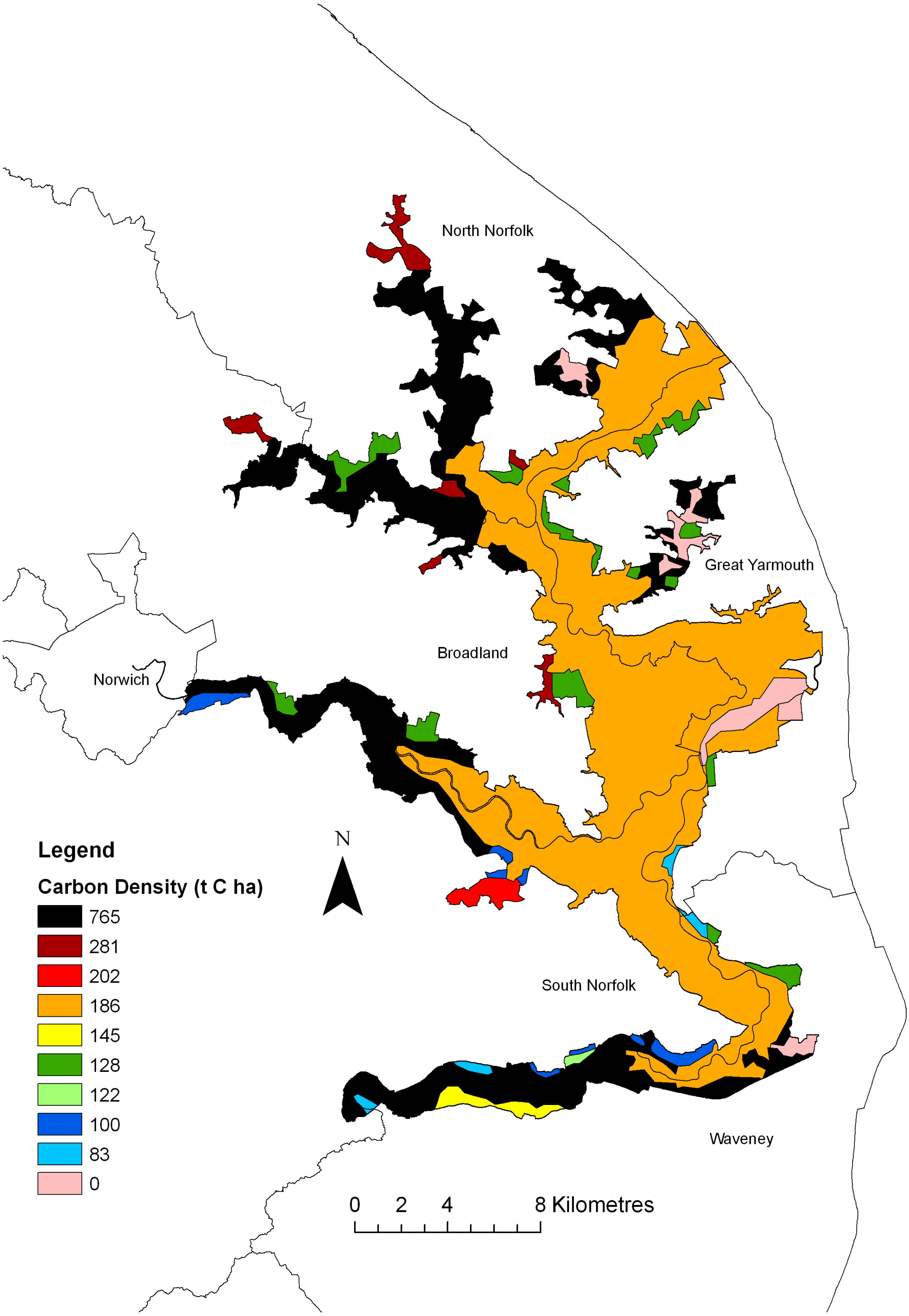
Cantley ~154,000 tCO_2e

The British Sugar Cantley factory lies within the boundaries of the BA executive area and, at around 154,000 tonnes CO_2 per annum, estimated emissions are significant. As such, the BA should encourage and assist Cantley to curb emissions as much as is possible.

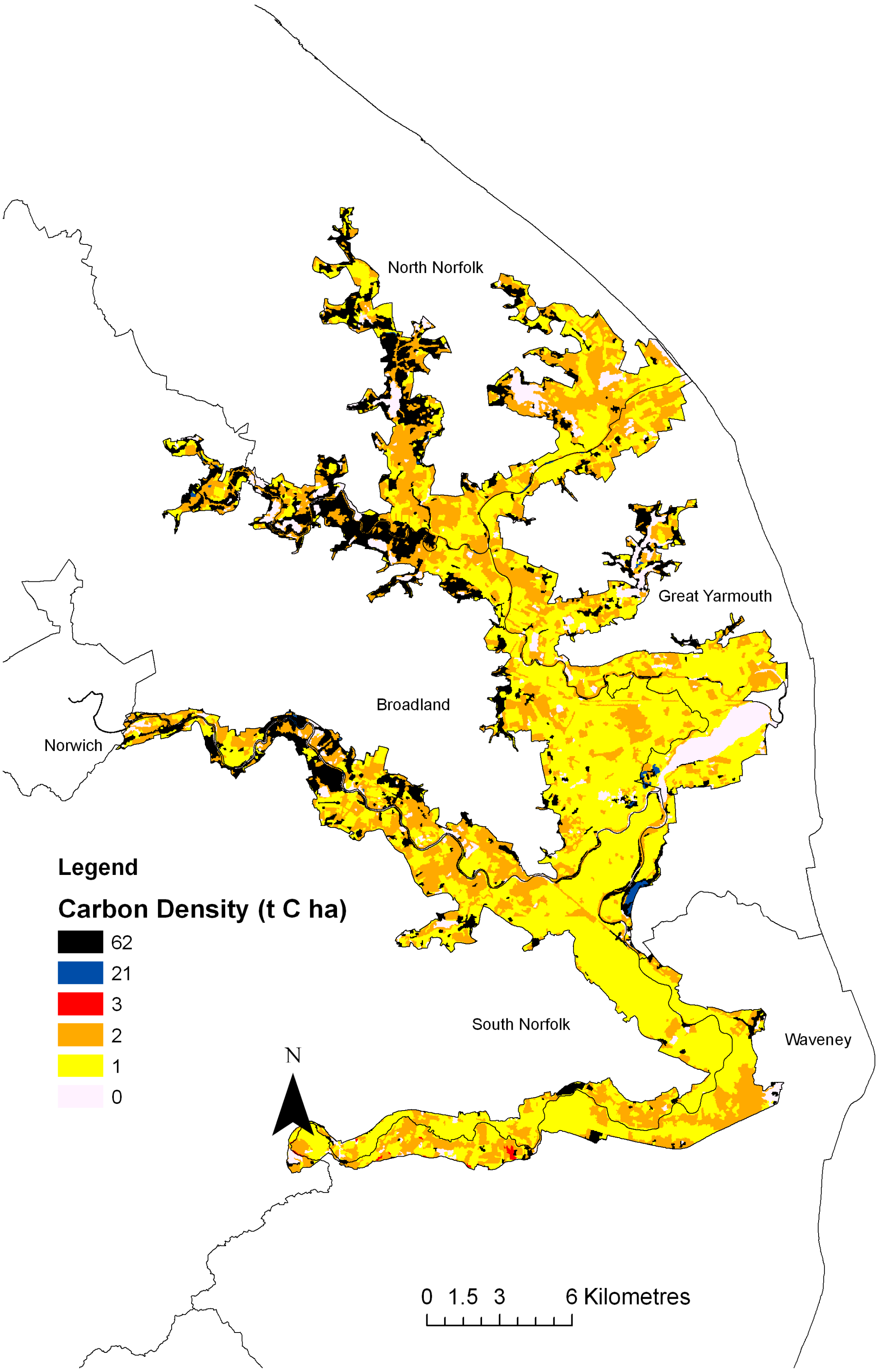
S/M/L

Annex A

Maps of Soil and Vegetation Carbon Stores



Annex AI.I: Distribution of soil carbon stores within the Broads Executive Area



Annex AI.II: Distribution of vegetation carbon stores within the Broads Executive Area