AGGREGATES – IS THERE A NEED FOR INDIGENOUS PRODUCTION IN ENGLAND?

***T.J. Brown*[1], *J. Mankelow*[1], *F. McEvoy*[1] and *J. Ward*[2]**

[1] *British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG*

[2] *Centre for Economics and Business Research, Unit 1, 4 Bath Street, London EC1V 9DX*

Abstract

Quality of life in a modern society depends on having the right infrastructure, of the right quality, in the right places – housing, schools, hospitals, transport links, workplaces and recreation facilities. All these elements of the built environment require aggregates in their construction. However many people today fail to make the connection between their standard of living and the quarries that are required to provide that standard.

With the opposition to mineral extraction becoming more vociferous and with increasing competition for land uses, this research project, funded through the Aggregates Levy, examined England's true 'need' for aggregates together with the costs and benefits to society and the economy of indigenous supply. It also considered whether it is physically possible to import large quantities of aggregates and assessed the likely implications of doing so.

The research found that the demand for aggregates is created by society's desire for a high standard of living and that the true 'need' is to meet that demand. It determined that aggregates extraction directly contributes £810 million to the English economy and this outweighs the estimated environmental cost of indigenous extraction of approximately £445 million. England's current aggregates requirement is more than double the existing port capacity for dry bulk cargoes and importing large quantities of aggregates would likely double the cost of this material, with serious consequences for downstream industries. There will continue to be a need to meet demand for aggregates and this will have to be provided mainly from indigenous sources for the foreseeable future.

Brown, T.J., Mankelow, J., McEvoy, F. and Ward, J. 2010.
Aggregates – is there a need for indigenous production in England?
Pp 18-23 in Scott, P.W. and Walton, G. (Eds.) Proceedings of the 15th Extractive Industry Geology Conference,
EIG Conferences Ltd, 186pp.
e-mail: tbrown@bgs.ac.uk

Introduction

Aggregates are the most widely used construction material in the UK. Domestically they are extracted in larger quantities than even fossil fuels - 241 million tonnes of aggregates were extracted in the UK in 2005 compared with 193 million tonnes of coal, oil and natural gas (converted to tonnes of oil equivalent). UK consumption of aggregates falls slightly below that of fossil fuels due to the higher level of imports for the latter (Office for National Statistics, 2007a). However, despite these large quantities, many sections of society are not as aware of their need for aggregates as they are of their requirement for energy minerals. This research attempts to make the connection between the standard of living society demands and the materials required to meet that demand.

This paper summarises the findings of a project, undertaken by the British Geological Survey in collaboration with the Centre for Economics and Business Research. It examines why society needs aggregates, quantifies the benefit aggregates extraction brings to the English economy, provides a monetary estimate for the environmental costs associated with extraction and considers whether it is possible to import all, or a substantial proportion of, the country's aggregates requirement. The full research report (Brown, *et al*, 2008) is available as a free download from www.mineralsUK.com.

The need for aggregates

Aggregates are used to build and maintain our houses, schools, hospitals, roads and offices. They provide a firm foundation for our railways, are used to construct factories, warehouses and shops, and can protect us against flooding. On average every person in England creates the demand for approximately four tonnes of aggregates per year and the real 'need' is to meet this demand.

Major infrastructure projects, e.g. the high speed rail link between central London and the Channel Tunnel, Terminal 5 at Heathrow Airport and the M6 Toll motorway in the Midlands, bring huge economic benefits to England. None of these could have been built without aggregates. Similarly, future projects such as the Olympic Park, Thames Gateway regeneration and Crossrail, will require millions of tonnes of aggregates. Adaptation and mitigation of climate change will also require substantial quantities for coastal and inland flood defences, renewable energy schemes such as the proposed Severn Barrage and for building new nuclear power stations. However, it is not just the large projects, which capture the public's attention, that require aggregates. Every year literally thousands of smaller structures are built, such as houses (which require up to 400 tonnes of aggregates per house) and schools (up to 15,000 tonnes depending on the size of the school).

There are many uses of aggregates for which there are currently no viable alternatives, e.g. in concrete, asphalt for road surfacing or as a drainage material. Even where buildings are constructed of alternative materials, such as steel and glass, often the structure will have a concrete core. In addition these alternative materials still require some form of mineral extraction, e.g. silica sand for glass manufacture, and consequently have many of the same issues as aggregates.

The intensity of use of primary aggregates has been falling in recent years (i.e. the quantity of aggregates used per £1000 of construction activity). This is partly as a result of the increasing use of secondary and recycled aggregates, partly due to improved efficiency of use of primary aggregates on construction sites but also as a result of the more complex and costly nature of modern buildings. However, there is likely to be limited scope for further minimisation of demand through efficiency savings and therefore this reduction in intensity of use probably cannot continue indefinitely.

The consumption of secondary and recycled aggregates has increased significantly in recent years and currently represents 26% of aggregates used in England. However, it is generally accepted that this figure is unlikely to be able to rise beyond 30% due to limitations on the availability of suitable source material (WRAP, 2006). Therefore primary material will continue to dominate the aggregates market.

Economic benefits of aggregates

The most obvious contribution made by any sector to the economic output of England is its 'direct contribution'. Wealth is created and employment is sustained as a result of customers purchasing aggregates. However, the contribution of any sector to the economy extends beyond this due to the links between different industries. The overall benefit to the economy is considerably greater due to these 'indirect contributions'.

There are a number of different ways of measuring these contributions. Gross output, or turnover, represents the total value of sales produced by an industry within a period of time. However, economic benefit is often measured in terms of '*Gross Value Added*' (GVA) which is defined as gross output minus the value of goods and services used to produce that output. There is a very close link between GVA and '*Gross Domestic Product*' (GDP) and the GVA of an industry can be thought of as its contribution to national GDP. There is also public interest in the employment that an industry sustains.

The direct contribution of the aggregates industry was estimated using National Statistics as being £810 million in 2005, as shown in Table 1. This figure excludes secondary and recycled aggregates, and material extracted for industrial uses, such as limestone used for cement. The industry directly employs 8,300 people, although this figure does not include self-employed hauliers who only work for the aggregates industry.

Contribution	GVA £million	Employment (number of jobs)
Direct	810	8 300
Upstream	188	4 680
Employee spend	51	1 211
Sub-total	**1 049**	**14 191**
Downstream:		
Ready mixed concrete	164	3 977
Coated Roadstone	65	370
Mortar	17	280
Concrete products	951	16 837
Sub-total	**1 197**	**21 464**
Downstream:		
Construction industry	**50 356**	**1 029 983**

Table 1. *Summary of economic contribution of the aggregates industry to the English economy (GVA = Gross Value Added).*

Indirect contributions can be divided into three components: upstream (the spending of the industry on its suppliers), employee spending (the employees of the industry spending their wages and salaries) and downstream (customers who purchase aggregates). All of these generate additional GVA contributions to the economy and support additional jobs. The downstream contribution of an industry cannot be simply added to the other economic benefits because the customers who purchase aggregates also buy other inputs (such as energy and other raw materials) in order to produce their products.

The upstream contribution can be calculated using input-output tables (Office for National Statistics, 2007b). These analyse the pattern of spending relationships between different parts of the economy, i.e. how much sector A spends on the outputs produced by sector B. The expenditure contribution can then be traced into GVA and employment. It has been estimated that the English aggregates industry spent approximately £753 million with its suppliers in 2005. By understanding the relationship between the amounts spent in these industries and the GVA and employment of these industries, estimates of the levels of upstream GVA and employment that is supported by the aggregates industry can be derived (see Table 1).

Direct employees of the English aggregates industry support economic activity as a result of spending of their wages and salaries. This creates a demand for goods and services from other parts of the economy. In 2005 the direct employees of the aggregates industry are estimated to have spent £108 million in the English economy which generated an additional £51 million of GVA (see Table 1).

Although aggregates are used directly, for example as a drainage medium, rail ballast or fill material, a large proportion is used in the manufacture of ready mixed concrete, coated roadstone (asphalt), mortars and concrete products such as pipes, roof tiles or paving slabs. The economic contribution of these industries is shown in Table 1.

The construction industry is the main purchaser of aggregates, either directly or via these related industries, with over 90% of the output from the aggregates industry going to construction. This industry spends more on purchasing aggregates than on any other raw material, either directly or contained within products such as concrete mentioned above. The construction industry is a major contributor to the English economy, with more than £50 billion worth of GVA in 2005 (see Table 1), which means it is only slightly smaller than the retail trade sector (£51.1 billion). It is also a sector which has grown significantly in recent years, from £31 billion in 1998; a growth rate of nearly 61% in 7 years. In addition, the construction industry employs 4.5% of the entire English workforce.

Environmental effects of the aggregates industry

To provide a balanced assessment of the need for indigenous supply, the research project was also tasked with considering whether the environmental 'costs' of having indigenous aggregates production were greater or less than the economic benefits the industry brings to the English economy. Whilst it is important to recognise that the industry does bring some environmental benefits, for example many biological and geological SSSIs are associated with quarries and the restoration of former extraction sites regularly contribute to the country meeting its Biological Action Plan targets, the industry does also result in some environmental costs. These costs can be divided into two categories:

- Amenity value – The general deterioration in 'amenity value' caused by extraction and transport of a bulk mineral, which includes noise, air pollution, traffic congestion, etc.
- Carbon dioxide emissions caused by quarrying itself and by the transportation of aggregates from the quarry to the point of consumption.

To compare these costs with the economic benefits identified, an attempt needs to be made to attach a monetised value to them.

Amenity value reduction

There are a number of different approaches to attach a value to this, and all methods have their advantages and disadvantages. However, in the time available it was considered that the best option was to update some earlier work carried out by London Economics (1999) to inform the debate surrounding the Aggregates Levy. This used a method known as 'Contingent Valuation' which, at its simplest, asks people how much they would be prepared to pay in order for something to be supplied (known as their 'willingness to pay'). A fuller description of this method, together with advantages and disadvantages is provided in the full project report (Brown, *et al.*, 2008) along with descriptions of alternative methods.

The London Economics' estimates of how much people would be 'willing to pay' for aggregates extraction to cease were derived in 1999 and since then income levels have risen noticeably. For most commodities when income levels increase the demand for them also increases, however, there are some commodities where higher income leads to lower demand. This research found that the 'willingness to pay' to offset a reduction in amenity value caused by aggregates extraction will increase as income levels increase, although the rise in the willingness to pay is not proportionate to the increase in income. Taking these things into account, together with incorporating the changes in extraction levels since 1999, the research estimated that the environmental 'cost' associated with amenity reduction was likely to range between £365 million and £410 million in 2005.

Carbon dioxide emissions

it is estimated that land-won primary aggregates extraction and transport in England accounted for just under 1,220,000 tonnes of carbon dioxide emissions in 2005. This figure includes the imports of crushed rock from Scotland. In addition, the landing of marine sand and gravel in England emitted a further 140,000 tonnes of carbon dioxide. These amount to 0.2 per cent of the total carbon dioxide emitted from the UK as a whole in 2005 (Department for Environment, Food and Rural Affairs, 2007a).

At the time of the research, the European Union's Emissions Trading Scheme had a price of around €22 per tonne of carbon dioxide emitted (European Union, 2008), which equates to approximately £16 per tonne. However, other work suggested that the 'social cost of carbon dioxide' is in the range of £23.30 to £25.50 per tonne emitted (Department for Environment, Food and Rural Affairs, 2007b). The 'cost' of the carbon dioxide emissions for primary aggregates in England is therefore estimated to be in the range of £21.8 million and £34.7 million per year. These figures represent only a broad estimation of the likely cost for carbon dioxide emissions and many assumptions have been used in their compilation. As more detailed research is conducted in this area it is expected that more precise and more accurate figures will be forthcoming.

Combining these two aspects together, it can be seen that the environmental 'cost' of indigenous aggregates production is less than £500 million per year, far less than the direct economic benefit the industry brings to the English economy.

Are significant imports a realistic option?

In order to determine whether there is a need for indigenous production, the research examined whether importing all, or a substantial part of, England's aggregates requirement is feasible. Importing aggregates from overseas requires a supply chain with several elements that all need to fit together if it is to be successful. These are shown in Figure 1. This research looked specifically at the shipping and receiving port

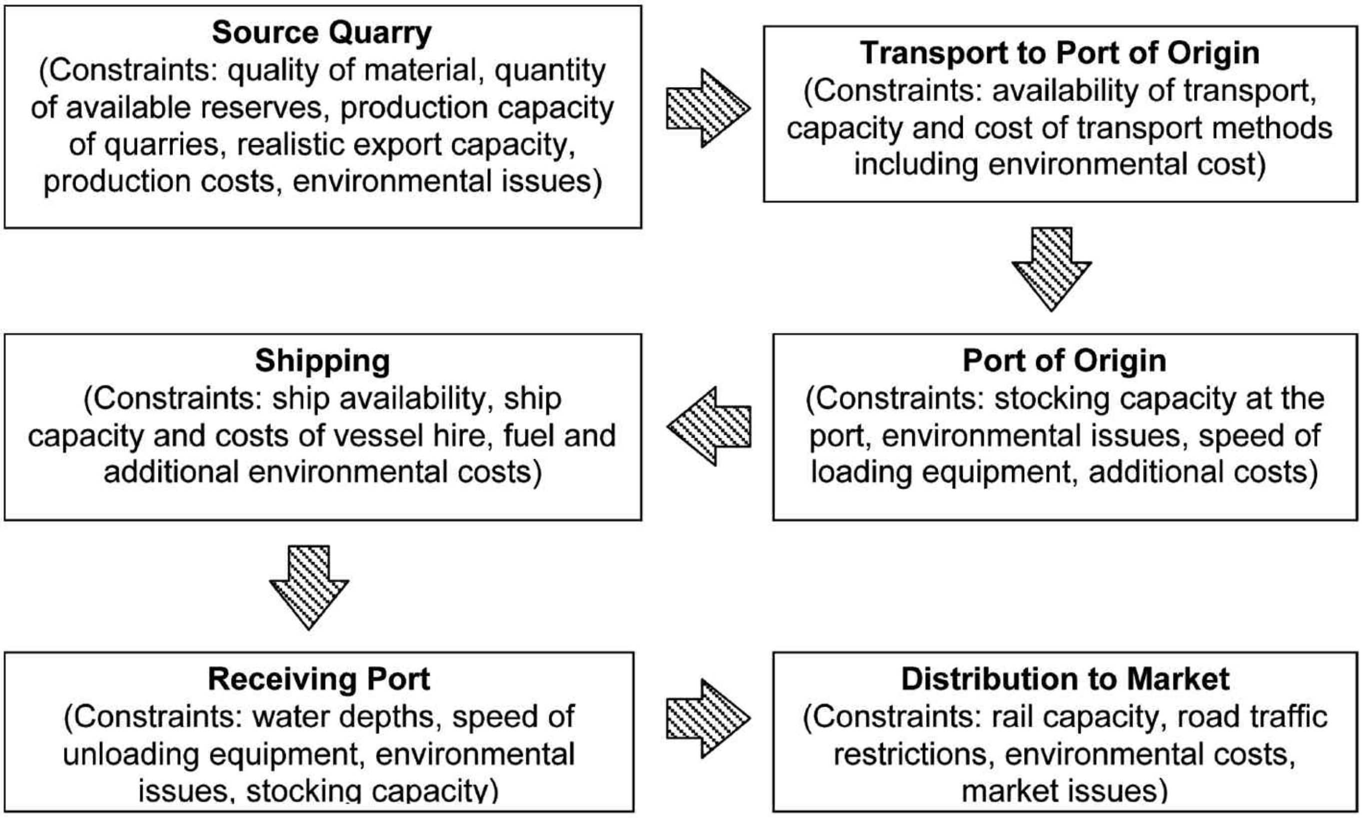

Figure 1. *The supply chain for importing aggregates from overseas with associated constraints.*

elements of this supply chain. It examined the issues of the additional costs associated with these and available capacity at English ports.

Shipping and Port Costs

The additional costs can be divided into three parts: the capital cost of using ships (whether purchased or leased), fuel costs and port charges. In order to estimate the likely increase in costs per tonne of aggregates imported a few assumptions are required, relating to:

- The size of ships that would be used – the analysis was carried out based on Panamax size ships. This represents a compromise between a larger ship being the more economical for bulk transportation and the limited number of deep water ports available in England to handle these vessels.
- Capacity utilisation – the analysis is based on a deadweight tonnage of 70,000 tonnes, with close to full capacity utilisation which implies a cargo of 65,000 tonnes of aggregates.
- The length of time a typical journey would take – the calculations are based on a typical journey of ten days. This is based on discussions with shipping industry experts who estimate that loading and discharging this quantity of aggregates would each take approximately three days. The time at sea is estimated to be two days per leg of the trip (four days for the round trip). This is an estimate of the time taken to sail from a representative quarry in Norway (which is a likely source of crushed rock imports) to the Port of Immingham where an estimate of the port costs was obtained. Shipping aggregates from Scotland currently takes longer than this.

A breakdown of the costs estimated by the research is shown in Table 2. International ship hire is currently at an unprecedented high (2008) but the figure shown was considered reasonable as a base estimate. Clearly, these costs can be saved if the ship is owned instead of leased. However, ownership of the vessel entails alternative costs, e.g. maintenance and crew salaries. While vessel hire rates are so high there is an additional 'opportunity cost' involved with shipping aggregates because ship owners could potentially earn more by hiring out their ships to transport higher value bulk goods. Fuel costs (also known as "bunker cost") are a function of the type of fuel used, fuel consumption rates at sea and in port, the respective length of time for each of these activities and the cost of fuel. Spot prices for these fuels increase and decrease with the price of oil, although some operators are able to obtain supplies on long-term contracts at lower prices. Port charges include items such as tug boats, river pilot and vessel handling charges.

Cost element	Cost per tonne of aggregates (£)
Vessel leasing	3.36
Fuel costs	0.42
Port charges	7.54
Total	**11.32**

Table 2. *Estimated costs associated with importing aggregates into England (see text for discussion and assumptions used).*

Combining these three items together it was estimated that importing 65,000 tonnes of aggregates into the Port of Immingham would be associated with costs of more than £11.30 per tonne (Table 2). Assuming that a typical 'ex-quarry' price at the originating quarry is the same as in the East Midlands region of England, i.e. approximately £10-12 per tonne for crushed rock, the additional cost of shipping and receiving port charges would effectively double the price of aggregates at the landing port.

Port Capacity

Dry bulk cargoes handled at major English ports, including both imports and exports, in 2005 amounted to 95.7 million tonnes. These include coal, iron and other metal ores, agricultural products, animal feed and similar products. By contrast, total sales of land-won aggregates in England have been in the range of 139-157 million tonnes over the last 10 years. Therefore if the total tonnage of dry bulk cargoes were replaced by imports of aggregates this would represent between 61% and 69% of England's aggregates requirement; a significant shortfall. However, it is highly unlikely that this could take place due to the much higher values associated with other dry bulk cargoes compared to aggregates.

If imports were to replace even a part of the country's aggregates requirement, there would need to be a significant increase in dry bulk cargoes through these ports. MDS Transmodal (2006) carried out research for the Department for Transport to provide estimates of traffic levels in dry bulk materials through major ports in Great Britain to 2030. Their modelling results suggested that approximately 10 per cent of forecasted traffic could not be accommodated at current port capacity and consequently concluded that:

"*The results for dry bulk traffic indicate that additional capacity might be required on some deep water estuaries over the next twenty-five years to handle deep-sea traffic, particularly coal imports that can only be accommodated on a few estuaries.*"

In other words, at tonnage levels for dry bulk cargos of around 110 million tonnes per year it was considered likely that there would be capacity constraints at key port infrastructure sites. Clearly, adding a significant amount of England's aggregates requirement would substantially exacerbate these constraints. A recent update of this work by MDS Transmodal (2007) has not significantly altered these forecasts and therefore do not alter the underlying conclusions.

Increasing port capacity is complex and expensive, e.g. the recent Humber International Terminal Phase 2 project at Immingham provided an additional 9.5 million tonnes of capacity at a capital cost of £59.5 million. In addition, it is by no means certain that such a substantial increase in port capacity is possible due to other limiting factors such as water depths in England's estuaries and availability of land. Even if port capacity were to be increased it is likely that higher value industries, such as those importing metal ores or coal, and non-dry cargoes such as liquefied natural gas (LNG), would successfully negotiate for space in these new facilities and lower value commodities, such as aggregates, would find it difficult to compete.

Furthermore, based on the journey time and ship capacity used in this study, one Panamax ship would be able to import a maximum of 2.3 million tonnes per year, assuming no additional time was lost due to maintenance of the vessel. To import the entirety of England's requirement for aggregates would therefore require approximately 65 Panamax ships (or larger numbers of smaller vessels). In the current situation where ships are in high demand it is doubtful whether such large numbers of ships would be available.

Importing the entirety, or even a substantial proportion, of England's aggregates requirements is not physically possible at current port capacity. Increasing capacity at England's ports is expensive and it is not feasible to increase it sufficiently to meet all, or a significant part of, the country's need for aggregates.

CONCLUSIONS

The demand for aggregates is created by society's requirements for new homes, hospitals, schools, etc and by the improvements to infrastructure which are closely linked to the economic growth of the country, such as new motorways, rail connections and airport terminals. Aggregates are also required for major, high profile, projects such as the Olympic Park and to mitigate the effects of climate change, e.g. in building new flood defences. The true 'need' for aggregates is to meet this demand in the interests of society and the economy.

The aggregates industry brings considerable economic benefits to the English economy, both directly and indirectly, which amounts to more than £1 billion of GVA (including direct contributions and those of the upstream and 'employee spend' contributions). However, the most significant benefit to the economy comes from the downstream customers of the aggregates industry which add more than £50 billion to the English economy each year.

These economic benefits far outweigh the estimated environmental 'cost' of having an indigenous aggregates industry, estimated in this research to be less than £500 million per year.

The volume of aggregates needed makes it impossible to import the entirety of England's requirement. Substantial investment will be required to increase port capacity if aggregates are to be imported in significantly larger quantities than at present. With secondary and recycled aggregates approaching the maximum available, there will continue to be a need for primary aggregates and these will have to be provided mainly from indigenous sources for the foreseeable future.

ACKNOWLEDGEMENTS

The research project entitled 'The need for non-energy indigenous mineral production in England' received funding from the Sustainable Land-won and Marine Dredged Aggregates Minerals Programme of the Aggregates Levy Sustainability Fund (ALSF) managed by the Minerals Industry Research Organisation (MIRO). The outputs of this project consist of two reports 'The need for indigenous aggregates production in England' (Brown, *et al*, 2008) and 'The need for indigenous fluorspar production in England' (Lusty, *et al*, 2008), both of which are available as free downloads from the BGS website (www.mineralsUK.com). Acknowledgement is made of the significant input to the research made by S Bloomfield, T Goussarova, N Shah and L Souron of CEBR. This paper is published with the permission of the Director of the British Geological Survey (NERC).

REFERENCES

Brown, T.J., McEvoy, F.M., Mankelow, J., Ward, J., Bloomfield, S., Goussarova, T., Shah, N., and Souron, L. 2008. The need for indigenous aggregates production in England. British Geological Survey, Keyworth, Nottingham, 74 pp. http://www.mineralsuk.com/downloads

Department for Environment, Food and Rural Affairs (Defra). 2007a. UK Climate Change Programme, Annual Report to Parliament. Available online at: http://www.defra.gov.uk/environment/climatechange/uk/ukccp/pdf/ukcc-annrpt-07.pdf

Department for Environment, Food and Rural Affairs (Defra). 2007b. The social cost of carbon and the shadow price of carbon: what they are, and how to use them in economic appraisal in the UK. Available online at: http://www.defra.gov.uk/environment/climatechange/research/carboncost/pdf/background.pdf

European Union (EU). 2008. Emissions Trading Scheme (EU ETS). Details available online at: http://ec.europa.eu/environment/climat/emission.htm

Lusty, P.A.J., Brown, T.J., Ward, J. and Bloomfield, S. 2008. The need for indigenous fluorspar production in England. British Geological Survey, Keyworth, Nottingham, 33 pp. http://www.mineralsuk.com/downloads

London Economics. 1999. The Environmental Costs and Benefits of the Supply of Aggregates – Phase 2. Department for Communities and Local Government. Available online at: http://www.communities.gov.uk/archived/publications/

MDS Transmodal. 2006. UK Port Demand Forecasts to 2030. Department for Transport. Available online at: http://www.dft.gov.uk/pgr/shippingports/ports/portspolicyreview/

MDS Transmodal. 2007. Update of UK Port Demand Forecasts to 2030 and Economic Value of Transhipment Study. Department for Transport. Available online at: http://www.dft.gov.uk/pgr/shippingports/ports/portspolicyreview/

Office for National Statistics, 2007a. Environmental Accounts, part of the National Accounts of the United Kingdom. Office for National Statistics publications.

Office for National Statistics, 2007b. Input-Output Annual Supply and Use Tables, part of the United Kingdom National Accounts. Office for National Statistics publications.

Waste and Resources Action Program (WRAP). 2006. The Sustainable Use of Resources for the Production of Aggregates in England. Available online at: http://www.aggregain.org.uk/sustainable_2.html