Site Waste Management Practices in Construction Industry in United Kingdom

A dissertation submitted to The University of Manchester for the degree of Master of Science in Environmental Sciences, Policy, and Management (MESPOM) in the Faculty of Engineering and Physical Sciences

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Abstract

The construction industry in United Kingdom has long been away from environmental issues including resource efficiency, waste management, etc. One of the main impacts that they have is the waste that they generate through their activities. Construction sector in UK is one of the fastest growing sector, it contributes to 8.2 % of the country's GDP and employs about 2.1 million people (DTI, 2006) and generates approximately 32% of the total waste generated in the country and most of the waste from this sector goes to landfill sites (Defra, 2004).

The government published a policy document in 2004 in order to try and initiate better waste management activities within the construction sector. The aim of this project is assess waste management practices within the sector. Overall objectives of this work are to review this policy document and see how it helps the industry to start with the waste management practices and what impact this policy has on construction activities (Chapter 2). Further, this work incorporates a few case studies which are based on sound waste management practices and discusses what sort of benefits they achieve after doing waste management (Chapter 3).

The last part of this project talks about a few alternatives or new options in terms of materials which could be promoted and used by the construction sector in UK in order to reduce the pressure on natural resources and to support waste management initiatives within the sector (Chapter 4).

Declaration

The work incorporated in the project report entitled **'Site Waste Management Practices in Construction Industry in United Kingdom'** is an independent study. Any such material which has been obtained from other sources has been duly acknowledged in the report.

I declare that this study has not been accepted for any other degree and it is also not currently being submitted in candidature for any other degree in another University.

Rohit Bhagwat
MESPOM
23rd May 2008

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It gives me an immense pleasure to thank Dr. W.H. Craig and Dr. Zoltan Illes for giving me the opportunity to work under them and giving precious guidance, criticism, and encouragement at all the stages which resulted in the completion of this work a successful one.

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Abbreviations

SWMP	Site Waste Management Plan
WEEE	Waste Electrical and Electronic Equipment
EU	European Union
GDP	Gross Domestic Product
EC	European Commission
CCI	Centre for Construction Innovation
CSR	Corporate Social Responsibility
ODPM	Office of Deputy Prime Minister
m^2	Square Meters
m^3	Cubic Meters

1. Introduction

The construction sector within the country contributes a major proportion to the total waste generation. The mission of this project is to assess the effect of UK's policy published in 2004 on construction waste management. This work includes policy review and how the companies are operating after this policy and what benefits they are getting after subscribing to this policy. Another objective of this work is to provide some alternatives in terms of materials so that the industry can reuse some of the recovered materials from C&D for new projects.

Environmental sustainability is the highlight of this century and issues related to this subject are being dealt with high prioritization. Waste produced by various sectors is increasing day by day and concerns over climate change, available land for waste disposal, landfill taxes, etc. are rising.

The Article 1(a) of the European Union's 'Framework Directive on Waste' gives the legal definition as '[W]aste' [means] any substance or object in the categories set out in Annex I (refer Appendix 1 for categories) of the directive, which the holder discards or intends or is required to discard'(EU, 2006). Various sectors including household, agriculture, mining, commercial, etc. contribute to total waste generation. Figure 1, shows the total waste generation along with contribution from various sectors.

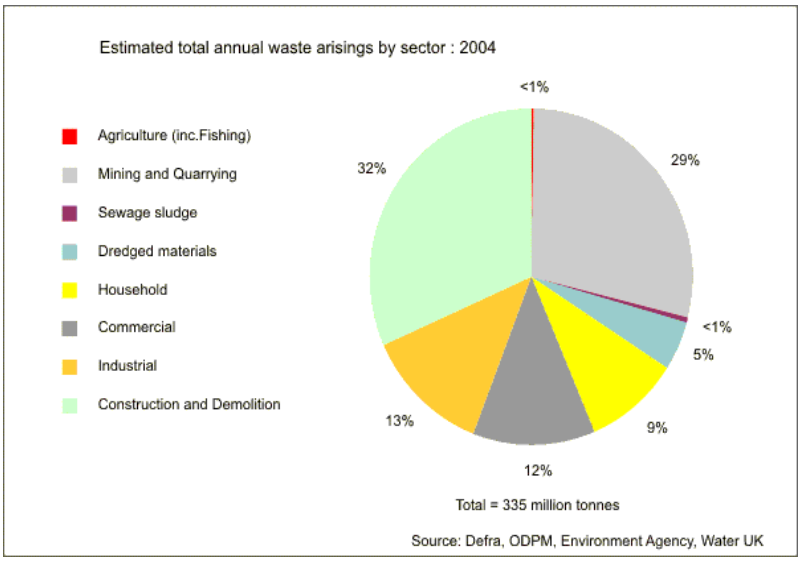

Figure 1: Total waste generation in United Kingdom in 2004

Source: Defra, 2004

According to Defra, in year 2004 total of 335 million tonnes of waste was generated which included approximately 100 million tonnes of minerals waste, and 220 million tonnes of controlled wastes from households, commerce, and industry which also includes construction and demolition wastes. The construction and demolition wastes include excavated soil and miscellaneous materials as well as hard materials and in Fig. 1 the data for this sector represent the data of 2002/03. (Defra, 2004)

1.1 Trend of Waste Management in United Kingdom

General trends in waste management in UK, fig. 2 show that during the period of 2001-05 the amount of waste incinerated, metal recycling and treatment and transfer has increased. Further, the waste quantity being landfilled has come down by 15 % but is still the most preferred option of waste management and the quantity of waste being landfilled is still significant (EA, 2006).

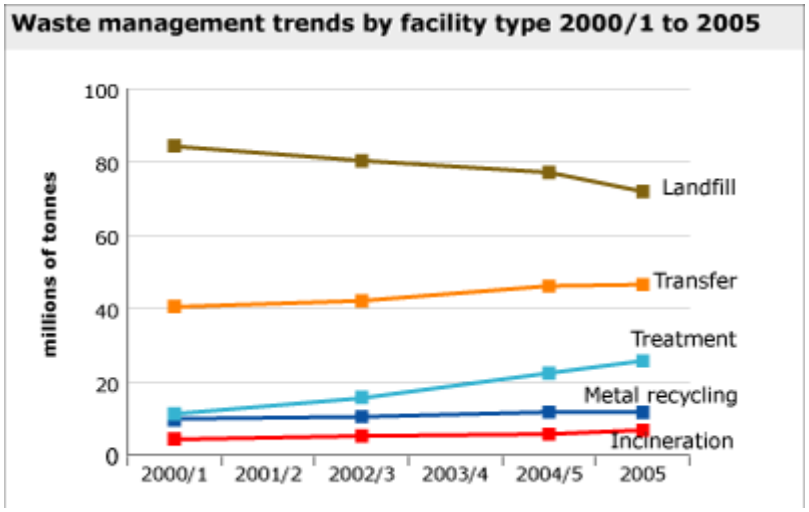

Figure 2: Waste Management Trends 1998/9 to 2005

Source: EA,(a) 2005

According to Environment Agency approximately 60 % of the total waste generated was sent to landfilling (EA, 2005). Of the total waste 6 % was incinerated, and 10 % was recycled and 22 % of the waste treated using various methods. The figure 3 shows the different methods used for waste handling and management.

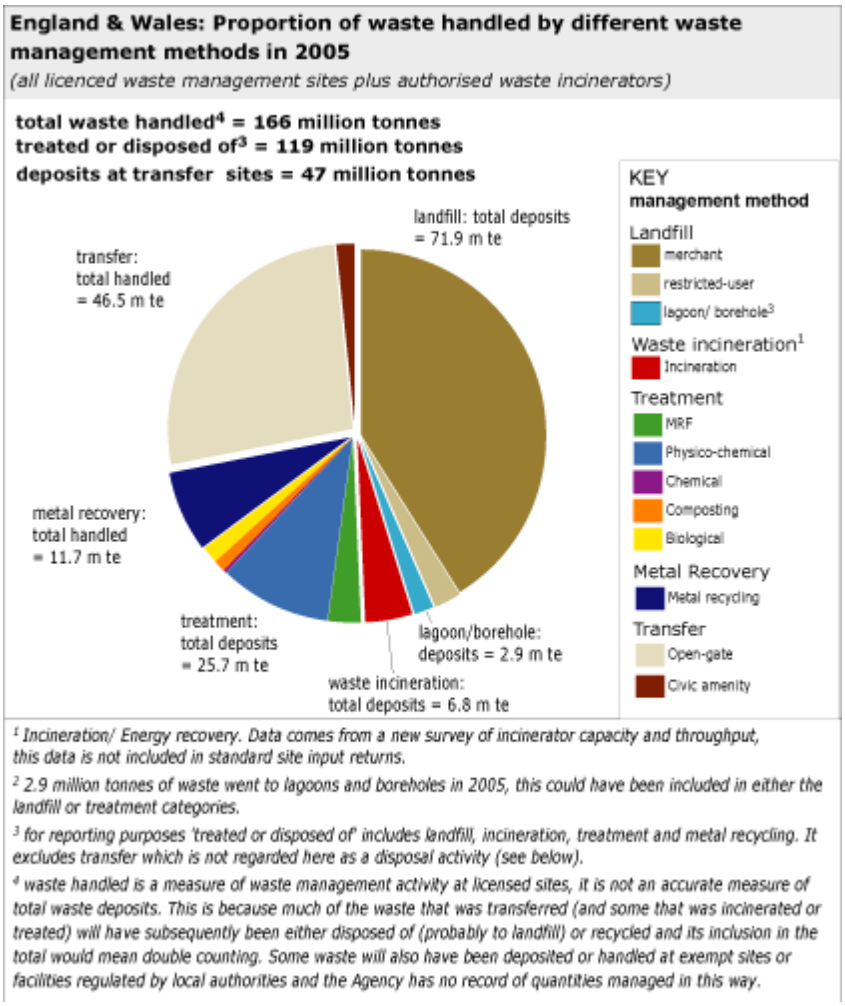

Figure 3: Waste handling using various management methods, 2005
Source: EA (b), 2005

1.2 Waste Hierarchy

The UK government is committed to sustainable waste management and their first step towards this is a waste management policy. The UK officials have published a updated planning document titled 'Waste strategy, 2007' (Defra (b), 2007) which talks about waste management issues and how the waste hierarchy shown in fig. 4 can be more firmly established.

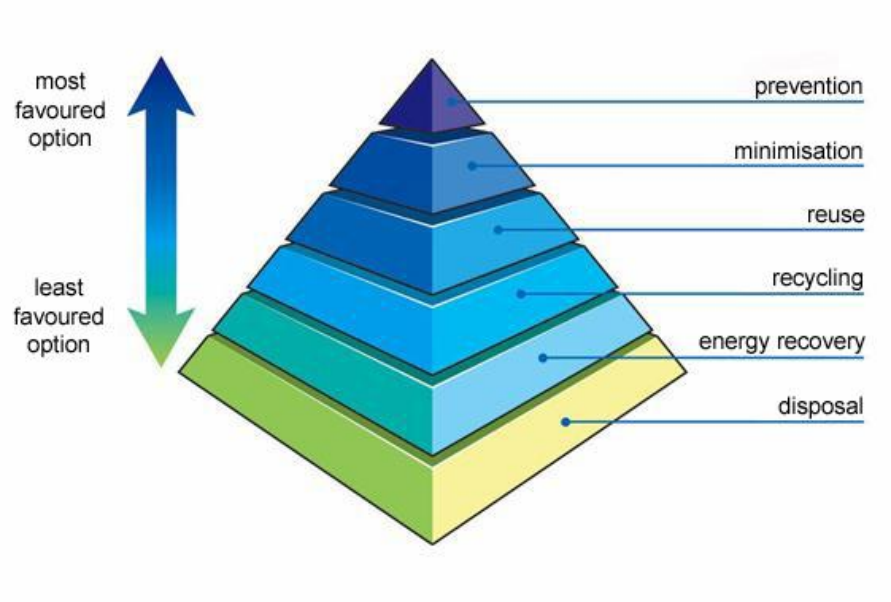

Figure 4: Waste hierarchy

Source:
http://www.wasteonline.org.uk/resources/InformationSheets/WasteDisposal_files/image005.jpg

Waste prevention is the most preferred option in the hierarchy. This concept lies within the principle of not generating waste during the company's activities, in other words this can be said as 'Zero Waste'. Further, is to minimise the waste generated. This can be achieved by using good project management practices, using materials that would generate less waste during production phase.

Principle of 3 'R' is to reduce, reuse and recycle the waste generated during company's activities. This would minimise the company's impact on the environment. The last option to be preferred should be disposal of the waste. Some time not all waste can be dealt with the above options, in that case disposal could be the option but this should be done in an appropriate manner.

Though moving towards 'Zero Waste' is not an immediately attainable status, the strategy has a long-term goal of move up the waste hierarchy in UK. Source reduction and waste minimization had been corner stones of the policy till now. Policies like Site Waste Management Plans (SWMP) with support of hazardous

waste regulations, EU directive on waste, WEEE directive, etc. would certainly reverse the trend of waste being sent to landfill sites for disposal in long term.

1.3 Landfills in United Kingdom

Around 60 % of the total waste generated in UK goes to landfill sites (EA, 2005). The land available for landfilling is reducing and land purchasing costs are also increasing. Apart from these two concerns, environmental impact caused by landfilling activities needs to be reflected in real sense. In order to reduce waste and motivate different sectors of the society, including the business sector towards recycling and reusing the government introduced Landfill tax in October 1996, based on 'Polluter Pays' principle.

Every year the landfill tax increases depending upon government's discretion. Currently, the landfill tax is charged at two rates based on type of waste namely Active waste, charged at £24 per tonne and Inactive waste having the dumping charge of £2 per tonne for all inactive waste. From April 2008 these rates are £32 per tonne for all active waste and £2.50 per tonne for all inactive waste, and the former is expected to rise to £40 per tonne for active waste by 2009 (Fig 5). (SITA, a)

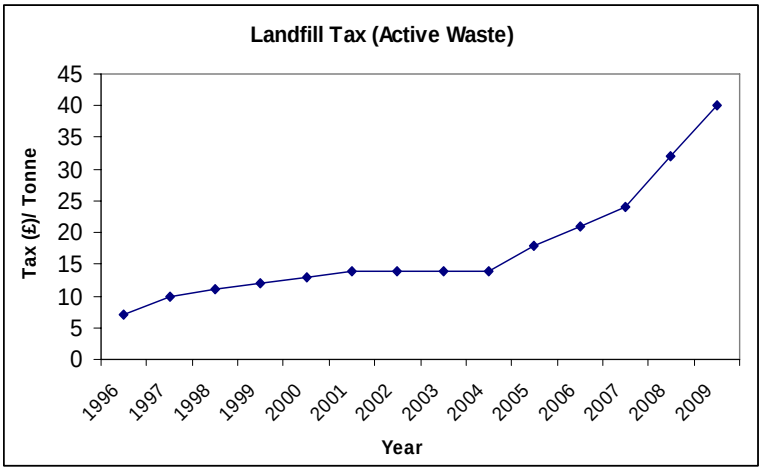

Figure 5: Landfill tax for active waste

The data available from Environment Agency shows in fig. 6 that in 2005 the available landfill sites have very limited life span. The London and East of England regions have 3 to 4 years of life at existing landfill sites; North West has 5 years, and South West 6. Elsewhere life expectancy ranges from 7 to 9 years. (EA, 2005)

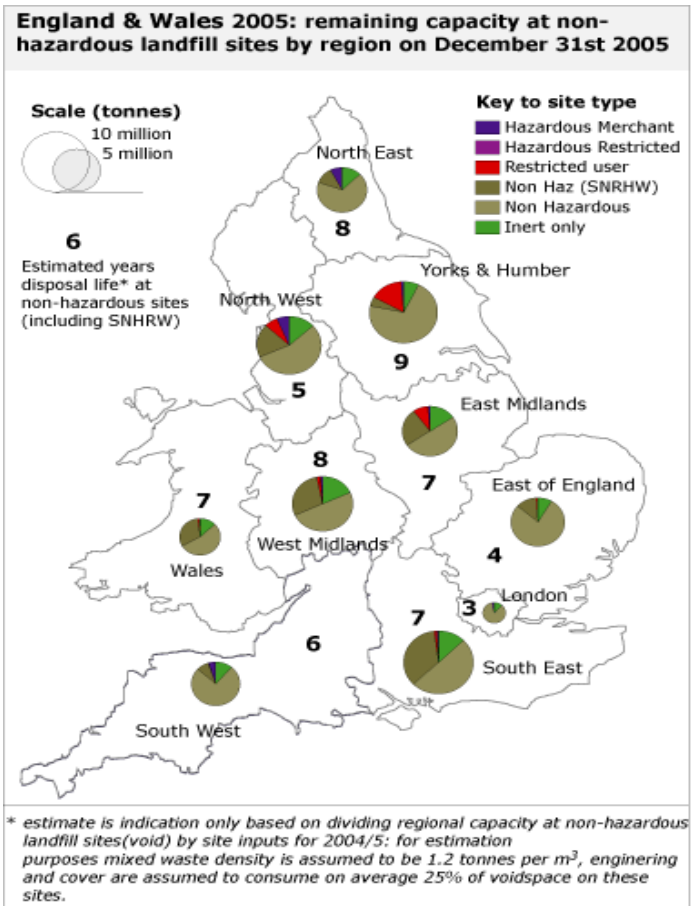

Figure 6: Capacity of Non-Hazardous landfill sites, 2005

Source:http://www.environmentagency.gov.uk/commondata/103196/1754705?referrer=/subjects/waste/1031954/315439/1720716/1746994/

1.4 Reducing environmental crime: Flytipping

As the landfill tax is increasing (Fig. 5), some of the companies tend to dump their waste illegally to avoid these taxes. Concerns over such illegal waste dumping or 'Flytipping' are growing in UK and this issue has been a crucial in UK for long time. The government spends £100 million every year to investigate and clear up the waste arising from Flytipping. (EA, 2002)

Till 2003 there was no real time data available for flytipping. In 2003 under section 55(5) of the Anti-Social Behaviour Act it was made possible to gather the data related to illegal waste dumping. Fig. 7 shows the flytipping problem within the

Local Authority area. Since then Local authorities are been encouraged to find flytipping incidences and report them to a database system which is called as 'flycapture'. For the same reason Defra is working closely with the Environment Agency, the Welsh Assembly Government. During the year 2006-07, about 982 illegal waste dumping incidents were dealt by Environment Authority and the estimated cost of clearance of flytipped waste reported by local authorities was £73.7 million (Defra (c), 2007).

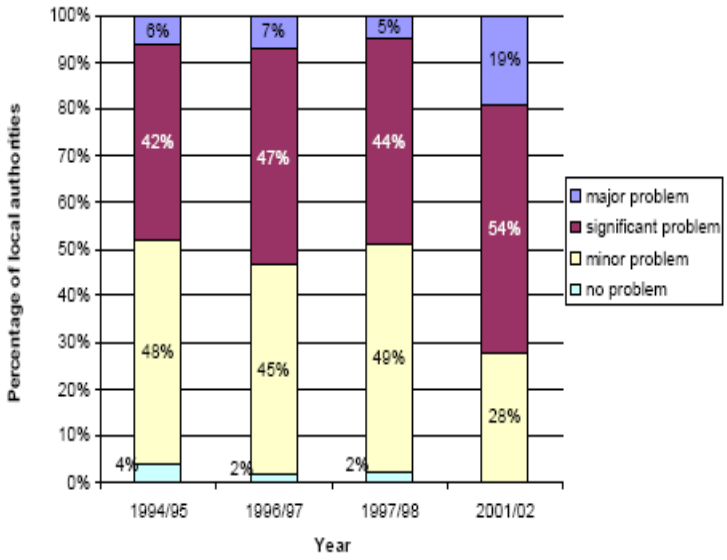

Figure 7: The fly-tipping problem in Local Authority areas
Source: Webb e*t al*., 2006

Following, the Clean Neighbourhoods and Environment Act 2005, the maximum penalty for flytipping ranges from £20,000 to £50,000. This is in line with the Government's desire to take a tougher stance on environmental crime and stresses the seriousness of illegally disposed waste. The maximum term of imprisonment will also be raised from 6 to 12 months when tried in the Magistrates Court. In the Crown Court all fly-tipping offences can attract a maximum penalty of 5 years imprisonment. (Defra, 2006)

1.5 Trend of Hazardous Waste generation in United Kingdom

Though most of the waste produced by the construction industry is inert or non-hazardous, a proportion of total waste contribution by this sector is hazardous waste. Therefore proper management of this hazardous waste is necessary. As the construction sector uses and produces hazardous materials and waste, it has to follow rules and regulations related to hazardous waste management, whether they are EU regulations or national regulations.

Article 1(4) of the Hazardous Waste Directive by EC (91/689/EC) defines hazardous waste as [Waste] having properties including "Explosive, Oxidising, Highly Flammable, Irritant, Harmful, Toxic, Carcinogenic, Corrosive, Infectious, Toxic for reproduction, Mutagenic, Ecotoxic", etc. mentioned in Annex III of 91/689/EC (EA, 2005).

The year 2006 was marked by 'chemicals & refining' sector contributing the biggest waste share in total hazardous waste generation in UK. Form fig 8 it can be seen that construction and demolition sector contributes almost 0.75 million tonnes of hazardous waste to total hazardous waste generated within the country which is approx. 12.5 % of the total hazardous waste generated in the same year. Out of 0.75 million tonnes generated by the sector approximately 80 % of hazardous waste is sent to landfill. On the positive side the recycling percentage of this waste has increased over the years. The incineration percentage of hazardous waste has also increased significantly (EA, 2006).

In early days non hazardous and hazardous wastes were disposed of in the same landfill area a process which was known as Co-disposal but now the hazardous waste has been declared as Special waste after the EU's directive on hazardous waste (91/689/EC), therefore now the hazardous waste is dealt with separately from other waste streams. The amendments in landfill regulation within the country have shown a positive impact on the amount of hazardous waste that is been disposed of in landfill (fig. 9) (EA, 2006).

There is a notable increase in recycling of waste due to various policy changes. A large increase in treatment of liquid waste was seen due to presence of waste treatment plant on Teesside. Earlier, the estuary was the disposal site for the

liquid waste. The figure 9 shows the overall trends in hazardous waste management methods used in UK (EA, 2006).

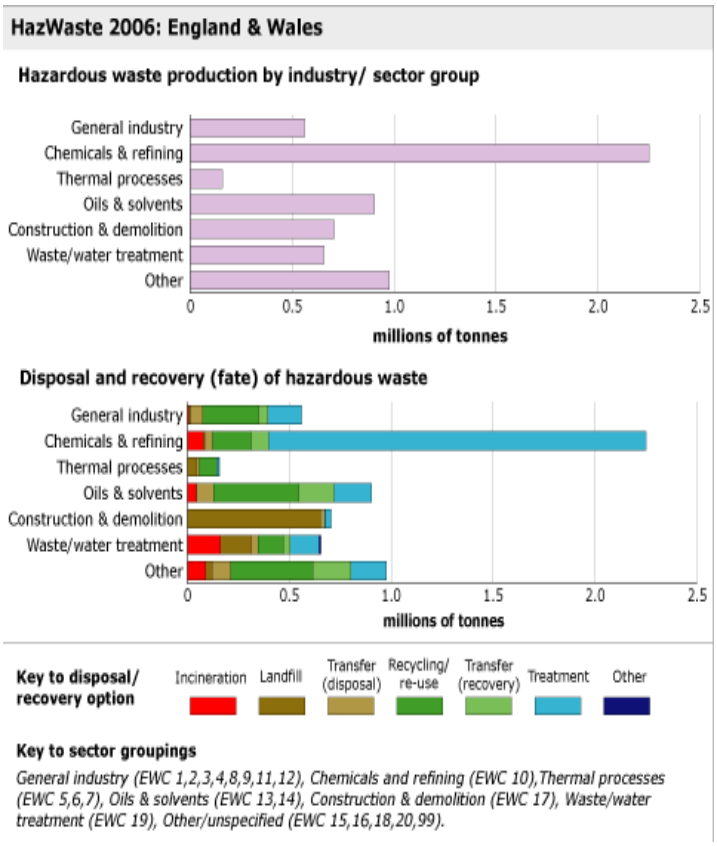

Figure 8: Production of hazardous waste in UK in 2006

Source: EA, 2006

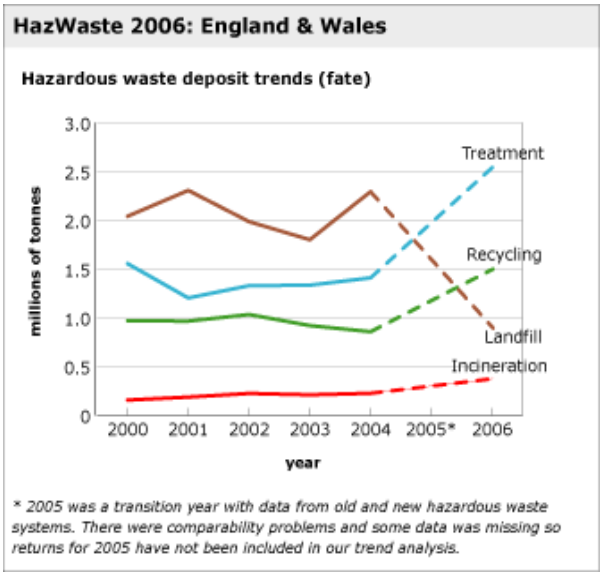

Figure 9: Hazardous waste management trends, 2000-06

Source: EA, 2006

1.6 Waste Management in Construction Industry in UK

The Construction industry in the United Kingdom is growing very fast. The sector contributes to 8.2 % of the country's GDP and employs about 2.1 million people (DTI, 2006). In England and Wales, the construction sector uses around 400 million tonnes of materials each year, generating 109 million tonnes of waste every year (Defra (a), 2007).

Approximately 13 % of the material delivered to the site is unused and is found in the skipped material. The Construction and Demolition sectors together are responsible for one fifth of the reported fly-tipping incidences and a third of serious incidences dealt by the Environment Agency (Defra (c), 2007).

Tables 1and 2 show the composition of waste generated during construction activities and what type of waste and how much of the total waste is active, inert, etc.

Material	Amount of total waste (%)
Hard material	32
Timber	24
Plastics	15
Cast formless	9
Gypsum material	6
Metals	6
Paper / cardboard	4
Bio-organic	3
Soil	1
Chemicals / paint	0.3

Table 1: Construction waste composition

Source: Modified from Simons Construction: Envirowise-WRAP, 2005

Material	Type of Waste	Quantity of total waste (%)
Timber	**Active 52%**	24
Plastics		15
Gypsum		6
Paper / card		4
Bio-organic		3
Hard material	**Inert 42%**	32
Cast formless		9
Soil		1
Metals	**Recyclable**	6
Chemicals / paint	**Hazardous**	0.3

Table 2: Construction waste classification as active and inactive

Source: Modified from Simons construction, Envirowise-WRAP, 2005

Trends in waste management

The construction waste management scenario in United Kingdom has not been very promising and waste generated from the sector has a contribution of around 30-32% of the total waste generated (fig. 1). According to a survey conducted by the Department for Communities and Local Government in 2005, it was estimated to be 89.6 million tonnes out of which 46 million tonnes were recycled and a further 15 million tonnes were spread and the remaining 28 million tonnes were sent to landfill which is a very big part of total waste generated by the sector (Defra, 2005).

Table 2 shows classification of construction waste as active, inert, recyclable, and hazardous, etc. Most of the inert material and part of active waste like bioorganic and timber etc. is disposed of in landfill. Further hazardous waste like chemicals and paint used in construction work has to be disposed of to specially designated landfills, as there is no other alternative other than possible incineration to dispose of the material.

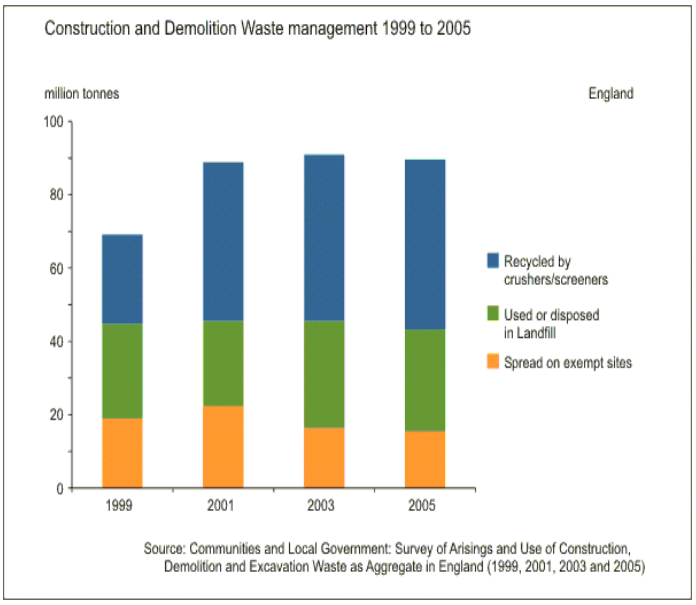

Figure 10: Construction waste management trend 1999-05

Source: Defra, 2005

Fig. 10 shows the trend of construction and demolition waste management in England. It can be seen that waste production with in the sector peaked during year 2003 and now has started coming down gradually. Though major portion of the waste is been recycled by the sector, the trend of disposing of waste in landfill has also been growing with respect to total waste generated by the sector. (Defra, 2005)

1.7 Construction industry sponsored programmes

1.7.1 Building Research Establishment Environmental Assessment Method (BREEAM)

The Building Research Establishment Environmental Assessment Method (BREEAM) was introduced in 1990. It has been formally recognized by the government as a methodical way to measure the environmental performance of buildings. The programme gives direction in order to minimize the adverse impacts of buildings on the global and local environment (CCI).

In the programme, performance based assessment is done against a broad range of environmental criteria including energy, transport, pollution which includes waste minimisation and management, materials, water, land use & ecology and health and presents the results in a way that is widely understood by those involved in property procurement and management and the building is "rated Excellent, Very Good, Good or Pass depending on the total score gained." (CCI)

Objective of BREEAM

By assessing the construction projects for various criteria, the programme tries to put business beyond a certain level where they would achieve minimum regulatory requirements and positioning the business in to a league of the best in business. A similar approach could be seen in other countries like Japan where programmes like 'Top Runner' (Tojo, 2007) are being introduced to various industrial sectors, which put the sector in the group where companies set a paradigm for others to follow.

This programme is a Certification scheme, where companies opt for this certification voluntarily. "This assessment is done independently & is credible as this programme is formally accepted by government. This assessment has holistic and customer focused approach" (CCI). The stages involved in the assessment are shown in the Fig. 11.

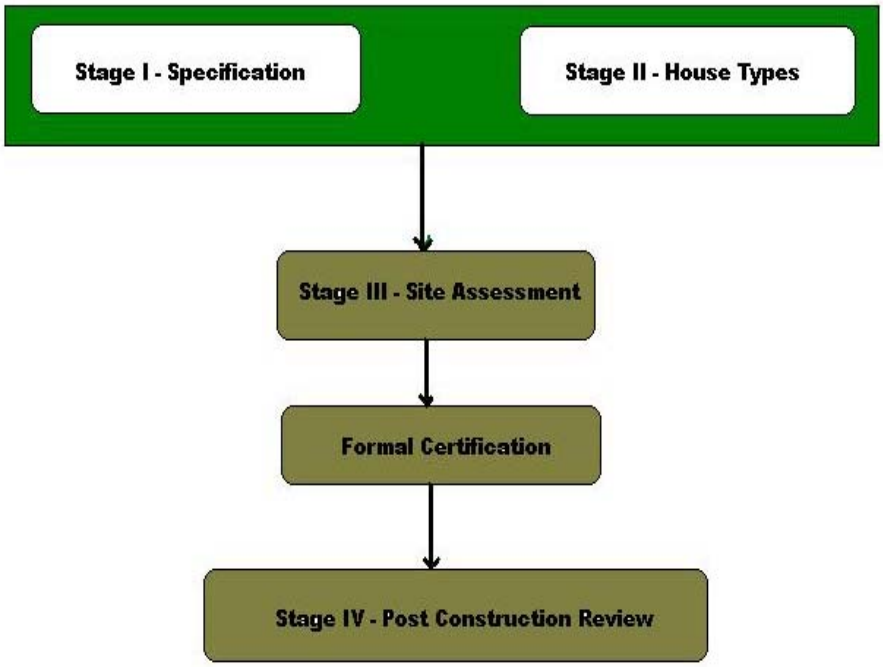

Figure 11: Assessment stages for BREEAM

Source: modified from http://www.ccinw.com/images/publications/Intro_BREEAM.pdf

1.7.2 The Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL)

The environmental quality and environmental performance of civil engineering projects are assessed under this scheme known as The Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL). "This programme is similar to BREEAM and is a civil engineering equivalent to BREEAM for buildings. This scheme is promoted by ICE, BRE, CIRIA, and a group of committed industry organizations." (CEEQUAL)

One of the objectives is to encourage environmental initiatives in civil engineering projects, and improve environmental performance for engineering projects for their design, and construction (CEEQUAL).

The Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL) have a methodical procedure to assess a project which is applicable to any civil engineering project. The scheme looks for inclusion of environmental aspects such as the use of water, energy and land as well as ecology,

landscape, nuisance to neighbours, archaeology, waste minimisation and management, and community amenity. “[This award scheme] publicly recognises the achievement of high environmental performance.” (CEEQUAL)

This scheme also has other benefits as subscription to this scheme demonstrates the commitment of the company to improve environmental quality and reduce the environmental impacts caused by company’s activities. Its also promotes improvement in environmental standards with in the company. As this scheme is well recognized and such award would help in improving company’s image in public in turn benefiting in company’s growth in sustainable way. (CEEQUAL)

2. Policy Review

The construction sector has long been away from the environmental issues. In order to achieve environmental sustainability, the government of UK published a site waste management planning policy for the construction sector. The Site Waste Management Plan (SWMP) was first introduced to the United Kingdom as a voluntary code of conduct in 2004 by the 'Department of Trade and Industries' as known by that time and now 'The Department for Business, Enterprise & Regulatory Reform (BERR)'. Initially, the policy was introduced for construction projects having an investment of £200,000 or more.

The SWMP policy document (DTI, 2004) provides a checklist and data sheet (appendix 3 and 4), which helps the person responsible for preparing a plan, and the plan can be modified according to company's needs and can be produced when required. The responsibility for writing the waste management plan may differ with respect to company and the level of the project. The developer, architect's representative, or client is responsible to make a SWMP at pre-planning stage, which encompasses design and waste issues.

Further, during the tender or construction phase the contractor is responsible for writing the SWMP (Envirowise, 2007). If the work is further assigned to a subcontractor to carry out the construction work, then a representative of the sub-contractor company, either site engineer or site surveyor, is responsible for preparing the SWMP (DTI, 2004).

The involvement of various stakeholders in achieving the waste minimization and resource efficiency is expected at various stages. The commitment and support from clients, in terms of promoting and encouraging the preparation of a SWMP is expected and clients can use this to improve their public image by mentioning it in Corporate Social Responsibility (CSR) report. Further, the design team which has a very important part to play in waste minimization can incorporate the best designs which go hand in hand with waste minimization/ reduction practices on the site (Envirowise, 2007).

From the planning side, regulators and local planning authorities can participate in implementation and monitoring of SWMP. Supply chain management plays an important role in waste minimization. Having flexible procurement/ material exchange policies as taking excess material back from suppliers can have a positive impact.

Further, a specialized sector within the waste management industry could be introduced like the waste management contactor who can help by providing services and expert guidance on waste minimization issues to the construction company. Other stakeholders like end users, the community on a broader scale and organizations involved in environmental issues can also encourage and participate in making and implementation of SWMP (Envirowise, 2007).

The Site Waste Management Plan helps the construction companies by achieving

1. "Better management of resources in terms of supply, storage and handling and resource efficiency
2. Compliance with other statutory and non- statutory regulations and contracts.
3. Minimization of costs involved in materials, waste, etc.
4. Better performance of company's environmental management system."

(Source: DTI, 2004)

This SWMP policy document also provides some immediate steps in order to make the SWMP.

1. Assigning responsibility and giving authority to the people during planning process and working stages of the specific project, which can carry out the SWMP effectively.
2. Identifying and classifying waste streams with in the specified project whether waste is hazardous and/ or non- hazardous, etc.
3. Waste hierarchy: identifying the waste management options for the specific project, this could be onsite as well as offsite.
4. Waste management locations: this involves identification of site and contactors for further waste management options, these could involve offsite recycling facilities, landfill sites (if the waste is to be discarded) etc.

5. Awareness and training of the construction workers including in-house planners, contractors, and subcontractors.
6. Project management involving the material and waste.
7. Quantification and tracking of the different waste streams and
8. Monitoring of the SWMP's implementation.
9. Review of SWMP for its performance, deficiencies and for continual improvement. (DTI,2004)

Figure 12 explains the stages, people responsible for SWMP and what steps should be taken in order to make SWMP effective.

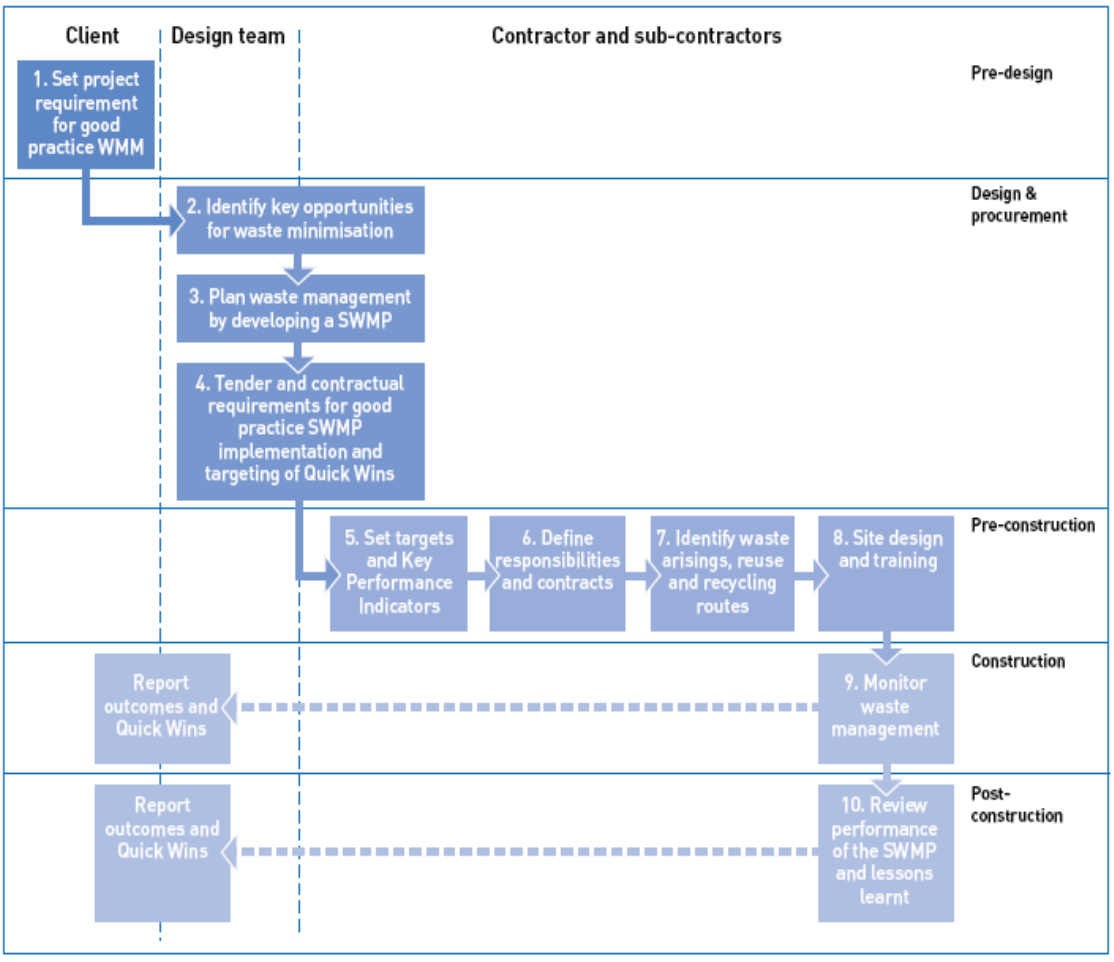

Figure 12: the stages, people responsible for SWMP

Source: WRAP.

The SWM Planning can be worked out at various stages from Fig. 12 where it can be seen that various stakeholders in the project can give their inputs at various levels. Starting from the client, when the project is proposed the client can ask for

sound waste management practices during the design phase and during the actual construction phase for the proposed project, where he can have a reporting facility to get time-to-time feedback on the work that is done with regards to waste management.

Further, during design phase the planners and the designers can put their intellectual concepts within the project design by incorporating building designs which would use less virgin material, can make use of recovered and recycled materials in the construction part, etc. They can also look for new opportunities where they can initiate new flexible procurement policies involving their supply chain partners within the waste management practices onsite as well as offsite. During the actual construction work the contractor or subcontractor can work out their own plans having in mind the ways to identify, segregate, and dispose of the waste streams that would be generated during the project work.

Also, by decentralizing the authority and responsibility of project management including waste management the contractor will have a better control of the work and will involve people from all levels that are needed to make the waste management plan work precisely as planned out.

Giving those authorized people the targets for the waste management would further give them certain checkpoints and would provide them an aim to reach for. This type of waste planning is a process of continual improvement and therefore measuring and monitoring the waste quantum is very essential.

Initially, it was required by the government's SWMP policy to have proper a data recording system even though the documentation to be produced was not subjected to any formal inspection according to SWMP, 2004. The other type of documentation required is 'Transfer Notes' which are produced during transfer of waste from one person to other, in this case from (construction works) client, contractor/sub-contractor, etc. to waste disposal/ waste recycling company.

These transfer notes be kept for two years from the date of their production. It is also necessary for the waste management company or the waste recycling company to have proper licences in place (DTI, 2004).

This regulation is meant to reduce the administrative burden by providing clients and contractors a tool which will help them ensuring compliance with other regulations. (Defra, 2007) The government is also trying to emphasize on 'Sustainable Construction' through 'Strategy for Sustainable Construction' published in 2000 (DTI, 2000) The SWMP supports the principles of stated in Strategy for Sustainable Construction.

Various other policies are also referred by the SWMP, including The Duty of Care mentioned in Environmental Protection Act 1990 and requirements for waste transfer notes mentioned in Environmental Protection (Duty of Care) Regulations 1991. The policy also refers to Waste Management- the Duty of Care, Code of Practice, 1996 and Special Waste regulations 2004. Further, Planning Policy Statement 10 'Planning for Sustainable Waste Management' (ODPM, 2005) also promotes SWMP by asking the new developments to prepare site waste management plans (Defra, 2007).

Initially, the SWMP code was a voluntary for construction companies for a trial period for one year (DTI, 2004) and subsequently it was carried forward till 2007 where it was felt that the voluntary subscription to this code was insufficient to encourage the necessary improved waste management practices in UK.

It was found that only big companies were interested and were working on SWMP. The purpose of this voluntary policy remained as informatory for the sector. Involvement of smaller companies was not seen after the publication of SWMP in 2004. Almost 4 years after this voluntary code was put in place very few case studies are available with respect to the number of construction companies that operate in UK (Defra, 2007). Therefore, to promote it on larger scale involving all levels of construction companies and strengthen the waste hierarchy in the sector, the government decided to make this policy mandatory.

DEFRA conducted a consultation over SWMP which was carried out between April 2nd to July 9th, 2007 and has been published in the form of a report titled 'Consultation on Site Waste Management Plans for the Construction Industry' includes responses on the questions including whether or not this policy should remain as voluntary code, if the policy is desirable what type of criterion should be

included, how detailed is the plan needed under this policy requirement etc. (Defra, 2007).

Following the consultations and detailed study the policy was made mandatory, from April 6th, 2008; the policy will be mandatory for the projects commencing a site after 1st July, 2008 and having the investment of £ 300,000 or more. (Defra, 2008)

3. Case studies

Very few construction projects are been identified which are related to good waste management. Most of the bigger construction companies opt for this kind of approach. As large number of companies operate in construction sector in UK; it is very difficult to get data from contractors, clients due to data security policy. Most of these case studies are published by Waste and Resources Action Programme (WRAP) along with CIRIA and Carillion Plc.

Case study 1: Project Green, Building 12, Bristol Harbourside

A commercial building was built at Bristol harbourside by Kier Build and has been designated as a 'Project Green' by the company as it involved waste management plans.

Figure 13: Construction site, Bristol Harbourside

This project was a five-storied building fig. 13, having floor space of 15,800 m^2 (approx.). The company used various approaches for the reducing waste. Principles behind achieving waste reduction had been prescription to BREEAM requirements. Further, cost reduction in waste disposal made the company think about their strategies regarding material procurement and storage.

The company's environmental responsibility towards society, other stakeholders, and their prescription to sustainable management initiatives put them a step ahead in waste management practices. The company also introduced a 'Strategy for Sustainability' within the company.

Some of the activities or practices used by the company in order to reduce the operational waste during this project work were:

- **Just in time approach**: This way of purchasing or ordering the materials needed for construction would reduce a lot of the waste generated during storage and double handling of the materials on the site.
- **Site inspection**: Inspecting and monitoring the materials used, activities being done on the site while their storage, handling and actual construction work would further reduce the waste generated during these activities.
- **Adequate and secured storage of materials**: Improper material storage on site would generally cause a lot of waste. Therefore adequate and secured storage is necessary in order to reduce waste during project activities. Materials like glass, plasterboards etc. needed to be stored properly. Fig.14 shows how the company has approached to the problem of storage.

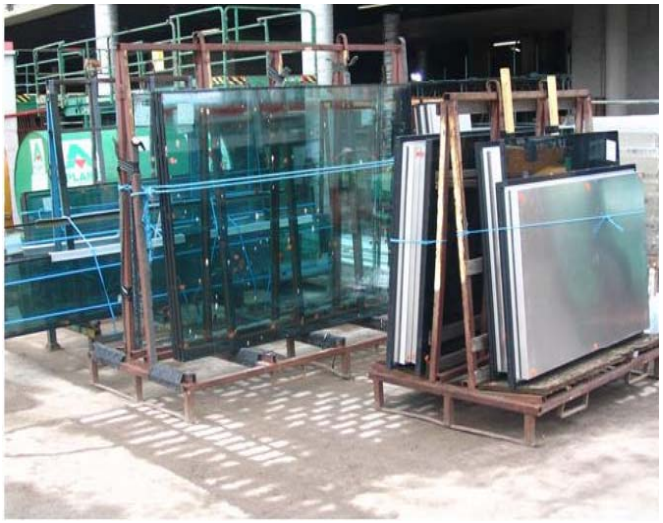

Figure 14: Glass storage system

Also, practices like proper project management, avoiding double handling of the materials have further reduced waste on site. Segregation of waste seen in fig. 15 helped the company to achieve waste hierarchy.

Figure 15: Segregation system

Information source:

http://www.wrap.org.uk/construction/construction_waste_minimisation_and_management/wman_case_studies.htm

Company: Kier Build.

Case study 2: Cardiff Sports Village

Previously, this site had been used for oil storage facilities; scrap yards, unlicensed, etc. An international sports village was planned on this site and the company that was developing the site was Taylor Woodrow Construction.

The project included residential area, casino, hotels, snow dome, ice rink, sports stadium. The site is a bay area and can be seen in fig.16

Figure 16: Project site, Cardiff Sports Village

Site waste management was one of the main objectives for this company, which also prescribed Environmental Management System that further streamlined it's environmental activities.

This project work became very difficult, as the site had been used for various activities which already damaged the soil quality at the site. The company used various methods to treat the soil and reuse it at the site.

- About 700,000 m^3 of soil contaminated with hydrocarbons were treated and reused on the site reducing waste generated. Approximately £8,142,000 was saved by not paying for waste disposal at landfill sites and purchasing virgin stone aggregates.
- 12,000 m^3 of soil contaminated with Japanese Knotweed was treated onsite. Further involvement of Environment Agency was taken. Approximately £550,000 were saved avoiding disposal of contaminated soil.

- Further, as a reuse initiative, Bentonite slurry which was available at the site was used to stop landfill gas and leachate avoiding 2500 m^3 of slurry being disposed of. A further 15,000 m^3 of material was salvaged and reused for compaction of landfill tip avoiding 3805 vehicle movements to the site.

Information source:

http://www.wrap.org.uk/construction/construction_waste_minimisation_and_management/wman_case_studies.htm

Company: Taylor Woodrow construction

Case study 3: Skeldergate, York

The 'Skeldergate project' is a residential project with 144 apartments in five blocks and is situated in the centre of the York. The site was used as a vehicle depot before this residential project was proposed at this site. Therefore demolition and reconstruction was the option for Taylor Woodrow Construction that developed this site.

Waste management initiatives at the site were one of the main features of the project being considered for good environmental practices. These activities would have generated a lot of demolition waste, which has to be disposed of. Instead the company used a different approach to tackle this issue. Waste management and resource efficiency were on the top of there choices.

- Initiatives like, onsite material recycling, plasterboard recycling, use of prefabricated parts in the construction reduced a lot of waste which otherwise had been produced.
- Demolition material from the previous vehicle depot was processed suitably and reused on the site for filling and as a piling mat. This also helped the company in reducing use of virgin material for the same purpose saving £21,000.
- A Plasterboard recycling scheme was initiated by the company in accordance with 'British Gypsum'. By using an organized collection system and proper storage and packaging practices (fig.17); the company was able to recycle 144m^3 of plasterboards.
- Further use of prefabricated material within construction activities reduced waste. Collaboration with 'NG Bailey' which is the supply chain partner of the company made it possible. Waste arising from wiring, pipe work, back boards, etc. was significantly reduced by use of prefabricated domestic energy centres, meter cupboard cabling, mains water pipes, etc. A net saving from these waste management practices was £10,000.

Figure 17: Plasterboard recycling

Information source:

http://www.wrap.org.uk/construction/construction_waste_minimisation_and_management/wman_case_studies.html

Company: Taylor Woodrow construction

Case study 4: The Great Western Hospital, Swindon

As an add-on to the existing hospital 'Princes Margaret Hospital' which was built in 1950's, a new well-equipped hospital for the existing population was proposed in Swindon. (fig.18) The project was under taken under the Carillion Building Special Project (CBSP). The total project investment was £100 Million to be invested through various sources.

The project was spread over approximately 13 hectares, having the floor space of 55,900 m^2. For this project the company used Sustainable Construction Initiatives (Carrilion Plc, 2002). These principles were incorporated in to the design, construction activities, and maintenance phases providing approximately £1,385,800 in terms of direct savings.

Figure 18: Proposed hospital site, Swindon

Waste management practices by the company.

Plasterboard waste accounts for almost 20% of the waste generated during construction activities, therefore the company worked with the plasterboard manufacturer on developing and modifying the existing design of the plasterboard. The design was modified from traditional double skin board to single skin which led to reduction in waste generated by plasterboard.

Further, the manufacturing company started using plasterboard pallets, fig. 19 instead of conventional wooden pallets for delivery of plasterboards on the site of

construction. These plasterboard pallets are reusable. The whole design modification let to reduction in the use of raw material by 50 %.

According to the company statistics about 717 tonnes of plasterboard were recycled, which saved £4860, in terms of landfill tax and £14,940 for skip transportation. The design change (fig. 20) let to direct financial savings of £200,000 and £ 85,000 by reducing use of paint coats on the plasterboards.

Figure 19: Plasterboard pallets used for delivery

Source: Carrilion Plc, 2002

Figure 20: Pre-cut sheets in use in the internal construction of the hospital

Source: Carrilion Plc, 2002

Further, the company used recyclable flooring for the hospital. The use of conventional material for the flooring purpose was taken over by the design and resource efficiency approach. Many options were considered for the flooring of the hospital including Lino, Rubber, Polyvinyl chloride (PVC), and Chlorine free vinyl. All these materials were tested against the sustainability criteria involving their life cycle, recycling, biodegradability, etc.

Finally, Rubber/Lino flooring which needs less maintenance, and less replacement, generating less waste was selected. Life cycle assessment of the material led to saving of £1.15 Million, largely associated with less frequent replacement of the flooring.

Table 3, shows the savings and other environmental benefits achieved due to waste management initiatives taken by the company.

Environmental Features	**Savings (£)**	**Environmental Benefits**
Efficient use of		
Plasterboard	433,800	Reduced waste to resources landfill should reduce the amount of leachates produced at a landfill site.
Recyclable flooring	1,150,000	Reduced waste to landfill should reduce the amount of leachates produced at a landfill site.
Total Direct Savings	1,583,800	

Table 3: Environmental activities by company

NB: These figures apply to the construction phase and concession period (27 years) for the company.

Source: Modified from Carrilion Plc, 2002

Information Source: Carrilion Plc, 2002

Case study 5: Knottingley Flood Alleviation Scheme

The project was developed in order to protect 244 properties by building a protection embankment and creating a wetland habitat of size of 6 hectares (fig. 21) which would further provide protection from flood. This project was undertaken by the Environment Agency along with Volker Stevin and WS Atkins and was completed April – September 2007.

The main feature of this project were to start waste minimization by designing the project in such a way that the construction would use recycled or reclaimed material from previous demolition work on that site. Another feature was project management and handling of the material. Further reduction in waste arisings was achieved due to proper segregation, precise quantification, and identification of different waste steams and other materials.

Figure 21: Project site, Knottingley Flood Alleviation Scheme

Source: Volker Stevin Ltd.

Major benefits of these practices were that approximately 25,000 m^3 of clay was reclaimed and used in building the protection embankment. The waste arisings from demolition were segregated and reused on the site. Further, 135 tonnes of sheet steel piles were recovered on site of which about 70 % were reused during construction work. A small quantity of asbestos was disposed of being hazardous material but other type of non hazardous waste arisings were reused to form a car parking a area and viewing platform on the site.

Information source: http://www.ciria.org/cwr/cs-knottingley.htm

Case study 6: Wessex Water Operations Centre, Claverton Down

This design-oriented project included all the aspects of waste minimisation, procurement, and management of waste at the same time. It was developed at Claverton Down near Bath. The total project cost was estimated to be £22.5 Million and was to house about 580 people.

The building was designed in such a way that the dimensions within the building were standardized, like curtain walling, window sizes, etc. which reduced waste arising due to different shapes of furniture items or commercial apparatus at different places.

The procurement or material management was done so that no excess material was bought and kept on the site, reducing waste generating due to improper storage of raw materials.

Also, proper segregation practices further helped in identifying the waste streams which could be recycled and reused onsite as well as offsite. The company developing this site introduced segregation systems for timber and metal waste which have benefited the company and thus reducing the waste to be disposed of.

The structural design was made such that the most of the excavated material could be reused onsite. About 5000 m^3 of excavated material was reused for building different sections of the project including site boundary walls, for back filling etc., saving £25000.

Further, good waste management practices at the site reduced the overall waste generated during the project and only about 1956 m^3 of waste was disposed offsite, reducing waste disposal to £57000 which was approximately 0.25 % of the total project cost.

For all the good waste management practices, the project was put forward as a Constructing Excellence demonstration project and project got excellent rating from BREEAM.

Information source: www.wrap.org.uk

WRAP case study: Grand designs for sustainable construction

Case study 7: Sherwood Park Hotel, Nottingham

Simons Construction Ltd. undertook the development of the Sherwood Park hotel, a 92 bedroom and office complex. This project is one of the good examples of company's initiatives of training its own employees as well as involving its supply chain partners mainly the suppliers.

Over 59 weeks the company managed to recover and recycle 247 tonnes of waste and about 1631 m^3 of waste was disposed offsite. One of the major initiatives taken by the company was training their own staff. This is one of the most important steps to proceed for sound waste management practices on site. The working staff does the most of the things which may influence the amount of waste generated during the project work.

Further to that, identifying the waste streams and segregating the waste makes recovery and recycling of the waste easy. In this case, the company did on site segregation and identifying streams as inert, metal, timber, hazardous. The company was able to send 68 % of their total waste for recycling.

Flexible procurement policies and involvement of the supply chain in such initiatives is necessary. Here the company involved its supplier and used 'returnable transit packaging' for incoming material and thus avoided un-necessary waste that could have been generated otherwise.

For all the good initiatives and good waste management practices the company got a 'Gold Award in the Green Organisation's 2004 'Green Apple Awards'.

Information source: WRAP

http://www.wrap.org.uk/downloads/Sherwood_Park_15Apr_CS.af0300f9.pdf

Company: Simons Construction

Case study 8: Langley Park Housing development, Beckenham

The project has been one of the biggest housing projects (fig. 22) for Laing Homes. Previously used as industrial land the site has the area of 43 hectares (approx.), which was difficult to develop as first it was necessary to demolish the industrial area. The waste generated would have been enormous.

Figure 22: Project area, Langley Park Housing development, Beckenham

During the complete development of the project, the company acted as client, designer, and contractor at different stages. The project design, management was difficult, and costs involved in disposing of the waste arising from demolition of previous infrastructure had to be borne by the company, who chose to initiate this project with different approach all together.

A way was developed where less material was to be disposed of from demolition and less procurement of virgin material. The company started recovering materials from the demolition activities, where they were able to recover 500,000 roofing tiles thus saving £480,000 by re-using those tiles along with some recovered demolition concrete.

It was estimated that about 40,000 tonnes of demolition spoil was reused as sub-base during construction and about £525,000 were saved due to waste management practices. Approximately, £600 was saved on each housing unit in the project by practicing meticulous approach of segregation of waste materials.

A flexible exchange agreement with the supplier for timber pellets and other packaging material further reduced the waste as those materials were reused for storage and packaging activities. Keeping records of the material input and output further helped the company to reduce the waste.

Raising awareness among the employees had helped the company in achieving desired waste management practices on the project site.

Information source: WRAP

http://www.wrap.org.uk/downloads/Langley_Park_15Apr_CS.6f13161a.pdf

Company: Laing Homes

4. Alternative materials for construction

4.1 Recycled Plastic Lumber

As an integral part of solid waste management in general, the construction industry can help by providing a new market for material called 'Recycled Plastic Lumber' This technology has been available since 1980's and still evolving. This material is generally recovered from post consumer recovered plastic or plastic mixed with some other materials. It is isolated from other waste streams, then cleaned, shredded and finally ground which before melted and mixed with UV stabilizers and colours. (King County, 2006)

Further this recycled plastic is moulded in to shapes and sizes according to requirement. This product can be seen in different sizes and shapes including Decks and docks, parking stops, benches, and other customized applications (fig. 23 and fig. 24). This material has been used in United States for a long time but this concept is getting hold in UK's construction sector very recently. Plastic lumber can be made from variety of plastics including High Density Polyethylene (HDPE), Linear Low Density Polyethylene (LLDPE), Low Density Polyethylene (LDPE), etc. These plastics are generally derived from water bottles, milk cartons, detergent bottles and other post consumer plastic waste. (King County, 2006)

Though this type of post consumer plastic waste is not directly related to construction and demolition waste, the construction sector can adopt a strategy to support waste minimisation of plastics on a broader scale.

Plastic lumber could be found in various forms as (King County, 2006):

All Plastic

A high-density polyethylene is a part of this type of plastic lumber. It needs low maintenance and has low replacement costs so could be used in various forms including decks and docks etc. It may have higher principle/ investment costs at initial stages.

Wood/Plastic Composite

This type of plastic lumber is generally a combination of 50 % sawdust and 50 % plastics. It has a property of higher stiffness than other type of plastic lumber products and is less expensive than others.

Fiber-Reinforced

"Fiber-reinforced plastic lumber consists of plastic mixed with chopped or continuous strands of glass fiber. The initial cost of this type is the highest of all, but its benefits are also greater, as it is the strongest of the three and could be used for structural applications."

Figure 23: Moulded plastic lumber

Source: www.builditgreen.org/guide.

Figure 24: Plastic lumber deck

Source: www.builditgreen.org/guide.

Environmental Benefits of using recycled plastic lumber

An alternative to high cost, high-energy consuming virgin plastic in construction projects is to use recycled plastic lumber. As this is made from recycled plastic it takes care of some of the post consumer plastic material. This recycling process also reduces problem of municipal plastic waste.

Further, this process of making recycled plastic lumber is less energy consuming than that of process for virgin plastic and is economically viable. It is also a good alternative to use of traditional hardwood, also saves trees from being cut down, and indirectly contributes to prevent climate change.

4.2 Eco-Concrete

In chapter 1 the construction and demolition (C&D) waste arisings in UK has been discussed. This C&D waste can now be used to manufacture concrete which can be used for various purposes during construction work. A company located in Singapore named Holcim (Singapore) Pte. Ltd. has made successful attempt to make and to use the concrete produced from C&D waste. This type of process closes the loop of aggregate production to waste. This could save resources used to produce virgin aggregates in the construction industry.

"[This Eco-concrete is made] from recycled aggregates from demolition waste which were used to replace 100% of the natural coarse aggregates, while washed copper slag substitute 70% of the natural sand component." (BCA, 2007)

Figure 25: Slump test comparison for normal concrete versus eco concrete

Source: Holcim (Singapore) Pte. Ltd., BCA, 2007

"[T]ests conducted on a trial mix design for Grade 30 Eco-concrete showed that the properties of eco-concrete are just as good as normal concrete (fig.25) in terms of workability, slump loss, and strength. The company is now working with HDB on a pilot study that involves the casting of a non-structural slab sample at one of HDB's Interim Upgrading Project at Simei to demonstrate that Eco-concrete performance matches that of conventional concrete in terms of strength and durability." (BCA, 2007)

Figure 26: Photo of non-suspended pavement slab taken at Simei HDB Interim upgrading project

Source: Holcim (Singapore) Pte. Ltd., BCA, 2007

Eco-concrete can be used for non-structural elements like walkway slabs (fig.26), park connectors, pedestrian footpaths, and cycling tracks. (BCA, 2007)

4.3 Reuse of Steel recovered from C&D waste

A major structural component in the construction industry is Steel. Recovery and reuse of structural steel components from C&D waste could be a better option to usage of virgin steel material for structures.

Structural components such as beams, columns or non-structural components such as cladding panels or staircases could be recovered and reused with minimum of processing for new construction projects. This can also include the reuse and adaptation of whole steel frames in situ (SSC, ?).

The principles of waste hierarchy can be used for usage of recycled steel in new construction projects by (Fig. 27):

1. "[Stripping] back and reusing the structure of an existing building on the same site.
2. [Dismantling] an existing structure and reuse the complete structure on a new site.
3. [Reusing] individual components such as beams, columns, cladding, and stairs from deconstructed buildings in new buildings with minimal reworking.
4. [Reusing] individual components such as beams, columns, cladding, and stairs from deconstructed buildings in new buildings with significant reworking.
5. [Sending recovered] steel to mills for recycling."

Source: SSC, ?

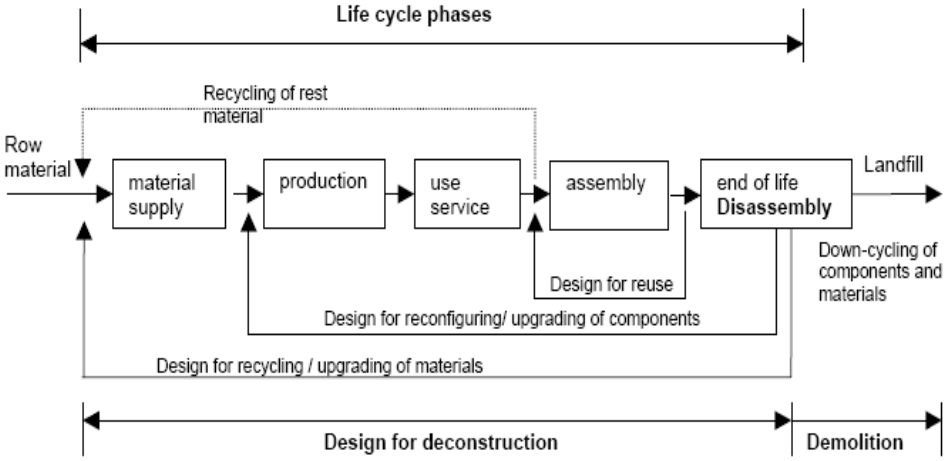

Figure 27: Potential close-loop for Steel usage in Construction

Source: Durmisevic and Noort, 2003

Issues involved with reuse of steel structures

New opportunities for reusing the steel components from C&D waste are making designers and planners think about their options to design a building or a construction project using the recovered steel. This market has not yet evolved to such extend that demand and supply of these materials would go hand in hand.

Another approach to reduce impact on environment could be a design change in the structural plan of a construction project. Projects with a plan of using recovered of steel components in new structures could be one of them. Coordination of recovery and reuse of these steel structures is necessary for such approach but is a very difficult process. This might delay the new project than as planned. Thus it is very difficult to use recovered steel components 'off the shelf' (SSC, ?).

Environmental Benefits of Steel Reuse

Production of virgin steel takes a lot of resources. A large amount of energy is required for the production, which contributes to issues including climate change. Reuse of steel needs very little processing and very little energy. "For steel this is confirmed by a study in the UK by the Steel Construction Institute which suggests

that reusing steel leads to significantly greater environmental benefits than steel recycling and correlates well with savings in greenhouse gas emissions." (SSC, ?)

Thus recovery and reuse of steel components from C&D waste has a positive environment impact, in terms of waste reduction, resource efficiency, and use of resources like steel to the fullest, thus completing the life cycle of steel by maximum usage of the steel (SSC, ?).

5. Discussion

The steps taken by the UK government to initiate better waste management in Construction and Demolition sector are creditable. Not many developed countries have taken this approach to tackle environmental issues and reduce the burden on natural resources. Such steps are necessary to promote sustainable development.

Similar kind of approaches could be seen in countries like Germany where a Commercial Wastes Ordinance was passed in 2003 (FMENCNS) which talks about reduction and highest possible quality recovery of construction and demolition wastes through that policy. Further, Australian government introduced 'National Government waste reduction and purchasing guidelines' in 2000 (DoEH) which also prioritize reduction in purchasing construction products and reducing demolition wastes.

Though developed country like USA does not have any comprehensible nation wide policy for construction and demolition waste, some of the states have their own policies, e.g. California has an 'Integrated Waste Management' policy (CIWMB, 2008) which includes regulations regarding construction and demolition waste management. Also Vermont has developed a policy under the name 'Reducing Vermont's Construction Waste' (SoV, 2003) would certainly help to reduce the pressure on the environment.

Such policies are very important and their implementation certainly needs same importance. The SWMP policy in UK has just become a mandatory one for the projects commencing from July 2008. It is necessary to see their level of implementation. Policies cannot be successful without awareness by the stakeholders.

Benefits could be seen from managing the construction and demolition waste. Very recently major contractors, and industry groups in UK have agreed to minimise their waste and those groups are working with the government and WRAP. Further, attitudes of designers and planners have begun to change as they can see new opportunities for using demolition waste. Such pioneering work will change the outlook of the whole construction industry towards the construction and demolition waste as a new resource rather than just waste to be thrown away.

The whole process of implementation of this policy should be continuously reviewed and developed, as it will need amendments from time to time to make it more efficient and better.

6. Conclusion

The construction and demolition sector in UK contributes to a large extent to total waste production in the country. Taking initiatives to reduce the waste generated by the construction companies is very necessary in order to keep development of this sector in a sustainable way.

It was seen that till the UK government introduced the Site Waste Management Plan in 2004 not much work was done to initiate improved waste management practices and strengthening of waste hierarchy within the construction sector.

In 2004, steps were taken from the government to put the construction sector within the parameters of managing their own waste and promoting good waste management practices. The Site Waste Management Plan was introduced as a voluntary code to initiate the process. But it was seen in 2007 that not many companies were opting for this voluntary code. Therefore after consultation in 2007 government finally decided to make this voluntary code a mandatory one.

The companies involved in the SWMP at the initial phase of voluntary subscription to this policy have used various approaches and were able to achieve good results by working on the SWM plans. Practicing various approaches of waste minimisation, management, design change, procurement policies, involvement of supply chain partners, awareness in staff etc. has helped them to reduce the impact of the construction industry on the environment in terms of waste disposal, usage of virgin raw material and has directed them to promote resource efficiency and sustainability in long term.

Use of alternative materials such as recovered and recycled material from construction and demolition waste, or from municipal solid waste could be another way to approach the overall problem of waste by the sector. Materials like recovered steel, recycled plastic lumber, Eco-concrete are examples of how companies can make use of such materials. Some of the technologies are still evolving and a need growing market to promote such materials and technologies and this can be provided by the construction sector in UK. More research should be carried out in order to recover and reuse more waste types from construction and demolition waste.

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43. Sherwood Park Hotel. WRAP: Simons Construction.
http://www.wrap.org.uk/downloads/Sherwood_Park_15Apr_CS.af0300f9.pdf
44. State of Vermont (SoV). 2003. Waste Management Division. Reducing Vermont's Construction Waste.
http://www.anr.state.vt.us/dec/wastediv/recycling/candd.htm
45. Strategy for Sustainability. Kier Build.
http://www.kier.co.uk/sustain.pdf
46. Sustainable Steel Construction (SSC)
http://johnjing.co.nz/green_web/reuse.php
47. SWMP checklist.
http://www.netregs.gov.uk/commondata/acrobat/swmp_checklist_1687085.pdf
48. The Civil Engineering Environmental Quality Assessment and Award Scheme. (CEEQUAL)
http://www.aeeuk.com/pdfs/ceequal.pdf
49. Waste and Resources Action Programme (WRAP): Case studies
http://www.wrap.org.uk/construction/construction_waste_minimisation_and_management/wman_case_studies.htm

8. Appendices

Appendix 1 - Categories of Wastes

1. “Production or consumption residues not otherwise specified below
2. Off-specification products
3. Products whose date for appropriate use has expired
4. Materials spilled, lost or having undergone other mishap, including any materials, equipment, etc., contaminated as a result of the mishap
5. Materials contaminated or soiled as a result of planned actions (e.g. residues from cleaning operations, packing materials, containers, etc.)
6. Unusable parts (e.g. reject batteries, exhausted catalysts, etc.)
7. Substances which no longer perform satisfactorily (e.g. contaminated acids, contaminated solvents, exhausted tempering salts, etc.)
8. Residues of industrial processes (e.g. slags, still bottoms, etc.)
9. Residues from pollution abatement processes (e.g. scrubber sludges, baghouse dusts, spent filters, etc.)
10. Machining/finishing residues (e.g. lathe turnings, mill scales, etc.)
11. Residues from raw materials extraction and processing (e.g. mining residues, oil field slops, etc.)
12. Adulterated materials (e.g. oils contaminated with PCBs, etc.)
13. Any materials, substances or products the use of which has been banned by law
14. Products for which the holder has no further use (e.g. agricultural, household, office, commercial and shop discards, etc.)
15. Contaminated materials, substances or products resulting from remedial action with respect to land
16. Any materials, substances, or products which are not contained in the abovementioned categories.”

Source: 2006/12/EC, Directive on Waste

Appendix 2: Site Waste Management Plan (Policy Document)

(**Abstracted from SWMP policy document, DTI, 2004**)

1. Introduction

Site Waste Management Plans (SWMPs) are an important tool for construction companies and their clients, of all sizes, to improve their environmental performance, meet regulatory controls and reduce rising costs of disposing of waste. This document sets out the basic structure of SWMP and how companies can best use it to improve and manage their operations at all stages of site activity. It includes useful checklists and other guidance to help ensure the Plan is a practical tool.

Why do you need an SWMP?

Adopting a site management approach based around an effective SWMP can bring your company many benefits including:

- Better control of risks relating to the materials and waste on your site,
- A tool to help you deal with any queries from, for example the environmental regulators, regarding wastes arising from your site,
- A mechanism to demonstrate to your clients how you manage your waste and minimise costs and risks to them,
- A tool to help you fulfil the requirements of your quality and environmental management systems,
- Compliance with likely future contractual requirements from public and private sector clients, and
- A system to help you and your workforce make cost savings by better managing your materials supply, materials storage, & handling and better managing your waste for recovery or disposal.

How to use this document

The background information on SWMPs is based upon the experience of some of the UK's leading construction companies and gives you useful guidance on how an SWMP relates to your legal obligations with regard to definitions of waste

and includes references to good practice, (for further information see the web-links at section 7.1).

Use the Key Steps (section 3, pages 5 & 6) and follow the signposts to the guidance, checklists that will help you quickly create an effective SWMP.

Identify and measure your waste to enable completion of the Site Data Form. This will help you relate your particular site characteristics to the different elements of the SWMP. For example, if there are no demolition operations on your site then you can ignore the sections relating to this.

2. Background

The purpose of this document is to:

• Assist Contractors in the development and roll out of Site Waste Management Plans

• Ensure that all Contractors are aware of their legal duties when dealing with waste

• Highlight the examples of best practice that will assist companies with compliance.

This guidance document is intended for use by companies engaged in projects of £200,000 or more in value. Other, smaller companies or smaller projects may also find the guidance useful. In any construction project, there may be a variety of different wastes to be dealt with, from office and canteen waste to asbestos and clinical waste. Coupled with this range of wastes is an array of legislation on how the waste is to be dealt with, combined with ever increasing prices for the legitimate disposal of waste due to increasing standards of environmental protection at waste management sites and rises in the Landfill tax.

Not only is waste becoming more and more expensive to dispose of, it also amounts to waste of valuable resources. And as landfill gets more scarce, we have to start being more innovative with what we do with our waste and look to manage it far more effectively.

3. Guide to Formulating a Site Waste Management Plan

There are nine important steps to producing a Site Waste Management Plan:

Step 1 – Identify who is responsible for producing the SWMP and ensuring that it is followed – and make sure that they know who they are! Different individuals may be responsible during the planning stages and the site-work stages. They must know that

they are responsible and what they are responsible for. They must have sufficient authority to ensure that others comply with the SWMP.

Step 2 – Identify the types and quantities of waste that will be produced at all stages of the work programme/plan. (See the Site Data Form and checklist points). Site Waste Management Plans

Step 3 – Identify waste management options including reference to the waste hierarchy, on- and off-site options and pay particular attention to arrangements for identifying and managing any hazardous wastes produced.

Step 4 – Identify waste management sites and contractors for all wastes that require them and ensure that the contracts are in place, emphasising compliance with legal responsibilities such as the Duty of Care. (See Site Data Form)

Step 5 - Carry out any necessary training of in-house and sub-contract staff so that everyone understands the requirements of your Site Waste Management Plan.

Step 6 – Plan for efficient materials and waste handling and do this early enough bearing in mind any constraints imposed by the site and it's location. Based upon steps 2-6 develop indicative percentage targets for each disposal or waste stream and record on datasheet.

Step 7 – Measure how much waste and what types of waste are produced and compare these against your SWMP to make sure your are on track to manage all wastes properly and to learn lessons for next time you have to produce an SWMP. These figures should be recorded on the datasheet.

Step 8 – Monitor the implementation of the SWMP to make sure that all is going according to plan, be prepared to update your plan if circumstances change, learn lessons for next time.

Step 9 – Review how the SWMP worked at the end of the project and identify learning points for next time – share these with colleagues who may be involved in preparing or using SWMPs so that they can benefit from your experiences also.

You may wish to compare your achieved percentages against your SWMP targets on the datasheet and identify learning points.

4. General Guidance on Waste and Legislation

4.1 Guidance

The following definitions and guidance is not intended to be an exhaustive in depth look at waste legislation. It is intended to give an initial overview of UK waste Legislation and outline our legal duties.. You are also encouraged to visit the 'NetRegs' website, which has specific information for a range of construction activities: www.netregs.gov.uk

5 Duty of Care - Your Responsibilities

All those who produce or handle wastes from demolition, earthworks, and construction activities have legal responsibilities – Duty of Care - for its safekeeping, transport and subsequent recovery or disposal. Failure to comply can result in an unlimited fine.

Duty of Care is a legal requirement under Section 34 of the Environmental Protection Act 1990. Detailed requirements for waste transfer notes are set out in the Environmental Protection (Duty of Care) Regulations 1991. 'Waste Management – The Duty of Care, Code of Practice' was published by the Government in March 1996.

Duty of Care requires you to take care of your waste while it's in your control, check that the person to whom you give your waste is authorised to receive it, make out a waste transfer note when the waste is handed over and to take all reasonable steps to prevent unauthorised handling or disposal by others. For example, checking that your waste goes to the intended facilities can avoid flytipping.

Examples of authorised persons are council waste collectors, registered waste carriers, holders of a waste management licence, or holders of a registration of an exemption from the need to hold a waste licence.

5.1 Filling in the Paperwork

When waste is passed from one person to another, the person taking the waste must have a written description of it and a transfer note must be filled in and signed

by both parties involved in the transfer. Repeated transfers of the same type of waste between the same parties can be covered by the one transfer note for up to one year. The transfer note must include:

- What the waste is, how much there is and its 6-digit European Waste Code
- What sort of containers it is in.
- The time, date, and place the waste was transferred.
- The names and addresses of both persons involved in the transfer.
- Details of which category of authorised person each one is e.g. producer, registered waste carrier, waste licence holder
- If either of the persons is a registered waste carrier, the certificate number of the registration
- If either of the persons has a waste management licence, the licence number of the facility.
- Where appropriate, the name and address of any broker involved in the transfer of waste
- Signed by both parties, and transfer notes kept for two years

5.2 Checking

- If you are dealing with hazardous wastes, such as asbestos, chemicals, oils or contaminated soils, you have extra legal responsibilities and may be required to complete detailed waste transfer consignment notes. If unsure, check with your local Environment Agency office: 0845 9 333 111.
- Check the registration certificate of the waste carrier before handing over the waste. This can be an A4-sized colour certificate (photocopies are not sufficient) or one that looks like a credit card. Both have security features built in.
- Check with your waste carrier where the waste is being taken and make sure the destination is authorised to receive it. If in doubt, check with the Environment Agency 0845 9 333 111. For difficult or bulky wastes, it may be appropriate to check that the waste wagons have actually delivered to the intended site.
- Be alert to any evidence or suspicion that demolition, earthworks or construction waste is being dealt with illegally. If you have any suspicions that someone is

handling waste illegally or using an unauthorised disposal site, contact the hotline number 0800 80 70 60.

5.3 What is waste?

For our purposes waste is defined as:

Any substance or object that you discard, intend to discard, or are required to discard is waste and as such is subject to a number of regulatory requirements. The term 'discard' has a special meaning. Even if material is sent for recycling or undergoes treatment in-house, it can still be waste. Whether or not a particular material is waste is for the person producing it to decide in accordance with the law.

5.4 Waste Classification

Wastes from construction, demolition, and excavation operations will normally be a controlled waste, classified as commercial or industrial waste, and hence subject to waste-related legislation.

Wastes from construction, demolition, and excavation operations will normally be a ‘controlled waste’ and hence subject to waste-related legislation. However certain types of controlled waste have properties that make them especially hazardous or difficult to dispose of. These wastes are referred to as Special Waste and require a pre-consignment note system for their recovery or disposal.

5.5 Special Waste

The Landfill Regulations 2002 have already implemented the European Hazardous waste list for landfill. Defra will publish their consultation on Hazardous waste in 2004.

As a result of these changes to the law, the term "Special Waste" is being replaced by the term "Hazardous Waste" to describe a wider number of wastes with hazardous properties and requiring new control measures.

6 Best Practice: waste minimisation

Following the guidance in Section 3, a Site Waste Management Plan for a particular contract will improve waste management practices and help to reduce the amount of waste produced (and associated costs). However, to obtain the best possible results a full waste minimisation initiative is undoubtedly the key to success

– particularly for larger projects. This section provides guidance on how to introduce the concept of waste minimisation.

6.1 Identify a Project Manager

It can be a daunting task to incorporate waste minimisation practices onto a contract. Before any action is taken a project leader (or 'champion') and project team should be in place. There can be no prescriptive rule as to who will make a good project manager for a waste minimisation programme. However he or she must be able to demonstrate a number of characteristics:

- The project leader must be able to communicate with staff and management.
- He or she should be able to put in place the required resources, information, staff motivation and training when necessary.
- A good knowledge of the contract and especially its operations side is also essential, and it may therefore suit a member of staff who has worked in several different sections, with a good overview of them all.
- Management must also recognise that the project leader will require time set aside for waste minimisation activities and make the necessary commitment.
- A project team should be appointed for larger contracts.

When the project leader and team have been established, the programme can get underway, following the steps below.

6.2 Programme Execution

The implementation of the waste minimisation changes require:

- Planning
- Ownership
- Staff education/training
- Monitoring

To have the greatest impact the programme should be a planned series of events, throughout which all the staff involved must be kept informed of progress. It is also beneficial if staff is given the opportunity to input to the process. Staff undertaking the waste producing processes often can provide practical details and become useful sources of information. Employees need to be told why the changes are happening and what the benefits will be. This is important, as initially the reason for the changes

may not be clear to the staff, as the benefit may be seen further down the line, at a process with which they have no involvement.

The monitoring of all changes is vital if the success of the programme is to be measured. A clear success indicator can be, for example, a reduced electricity bill, or reduced disposal costs.

7 Guide To Best Practice & Training Materials

7.1 General

There are varieties of examples of best practice in the preparation of site waste management plans. These are included in the websites of the various organizations listed - please see the links below:

www.smartwaste.co.uk
www.ciria.org.uk
www.constructingexcellence.org
www.envirowise.gov.uk
www.greenwich-village.co.uk
www.bre.co.uk
www.carillionplc.co.uk
www.defra.gov.uk/environment (+issue covered)
www.dti.gov.uk
www.netregs.gov.uk

Demolition Issues
http://www.ice.org.uk/downloads//Demolition%20Protocol%20%20Implementation%20Document%20-%20Final.pdf

Pollution prevention materials order form:
http://www.environmentagency.gov.uk/business/444251/444731/?version=1&lang=_e

Sample case studies, provided by Carillion plc are also available at:
Tool Box Talks
Everything from bats to wild parsnips!
http://www.carillionplc.com/sustain-2002/Z.Toolbox%20Talks.htm

*Case Studies
This link takes you to Carillion's internet site which details all of their case studies surrounding sustainability you will see that all aspects of sustainability are covered.
http://www.carillionplc.com/sustain-2002/Z.Case%20Records.htm
A case study from Carillion's works at Notts Tram
http://www.carillionplc.com/sustain-2001/case-records/notts%20tram.pdf

8 Guide To Appointing Waste Sub-Contractors

8.1 Nominated Representative

A ‘nominated representative’ of the lead sub-contractor company, normally either the site engineer or site surveyor, should have the responsibility of preparing the Site waste management plan and reporting its outcomes on the relevant data sheets to the client. The client would then notify the local authority.

9 General Reporting Requirements

9.1 Criteria and Circumstances for Reporting Via the Site Waste Management Plan Arrangements

These reporting arrangements are aimed at the medium to large sized companies engaged in any building, refurbishment, or civil engineering work. They are intended to encompass developments where the total value of a project is £200,000 or in excess of that sum. However, smaller companies will also gain operational improvements by introducing SWMPs on contracts of smaller value.

Companies should develop the format of their SWMPS to best suit their requirements, but are encouraged to follow the guidance given here to ensure that they cover all the key aspects required for such plans, including data reporting. A sample data-reporting sheet is provided.

(Source: Policy information modified from DTI, 2004)

Appendix 3 - Site Waste Management Plan Checklist

Project name	
Project address/location	
Main contractor: *Contractor details, including signature of authorised representative*	
Client signature	
Signature of identified sub-contractor (see Q3 & 4)	
Signature of identified sub-contractor (see Q3 & 4)	

Project Stages		Questions to consider	Tick if 'Yes'	Comment: If 'yes', what action have you taken/do you propose to take? If 'no', why not?
Policy	1	Has your organisation adopted a waste management policy?		
	2	Has the client signed the Site Waste Management Plan?		
	3	Have relevant sub-contractors producing significant wastes steams been identified?		
	4	Have the identified sub-contractors signed the Site Waste Management Plan?		
Procurement	5	Has a careful evaluation of materials been made so that over-ordering and site wastage is reduced?		
	6	Has full consideration been given to the use of secondary and recycled materials?		
	7	Is unwanted packaging to be returned to the supplier for recycling or re-use?		
	8	Can unused materials be returned to purchaser or used on another job?		
Project planning	9	Has responsibility for waste management planning and compliance with environmental legislation been assigned to a named individual at both main contractor and identified sub-contractors?		
	10	Has a project programme been developed to include likely waste arisings (how much, when, and what types)?		
	11	Has an area of the site been designated for waste management, including segregation of waste?		

Source: DTI, 2004

Project Stages		Questions to consider	Tick if 'Yes'	Comment: If 'yes', what action have you taken/do you propose to take? If 'no', why not?
Project planning	12	Have targets been set for the different types of waste likely to arise from the project?		
	13	Have measures been put in place to deal with expected (and unexpected) hazardous waste?		
	14	Has disposal of liquid wastes such as wash-down water and lubricants been considered?		
	15	Where relevant, has a discharge consent been obtained from the Agency?		
	16	Has agreement been sought from the sewerage company for trade effluent discharge?		
	17	Have opportunities been considered for re-use of materials on-site?		
	18	Have opportunities been considered for re-use of materials off-site?		
	19	Have opportunities been considered for on-site processing and re-use of materials?		
	20	Have opportunities been considered for reprocessing materials off-site?		
	21	Have you considered what are the most appropriate sites for disposal of residual waste from the project?		
	22	Are there opportunities for reducing disposal costs from waste materials which may have a commercial value?		
Site operations	24	Has responsibility for waste management on-site and compliance with environmental legislation been assigned to a named individual?		
	25	Have toolbox talks been planned for all site personnel about waste management on-site?		
	26	Are selected waste materials segregated to allow best value to be obtained from good waste management practices?		
	27	Are containers/skips clearly labelled to avoid confusion?		

Source: DTI, 2004

Project Stages		Questions to consider	Tick if 'Yes'	Comment: If 'yes', what action have you taken/do you propose to take? If 'no', why not?
Site operations	28	Are Duty of Care procedures complied with, including provision of transfer notes and checking authorisation of registered carriers, registered exempt sites and licensed waste management facilities?		
	29	Are any checks made that excavation waste is received at the intended site?		
	30	Is implementation of agreed waste management procedures monitored?		
	31	Are reports regularly produced regarding waste quantities and treatment/disposal routes, and on costs incurred?		
	32	During site operations, are barriers to good waste management practice considered and noted for incorporation into the post-completion review?		
Post completion	33	Has a final report of use of recycled and secondary materials, waste reduction, segregation, recovery and disposal, with costs and savings identified, been completed?		
	34	Has the final report been signed by the relevant sub-contractors and the client?		
	35	Have key waste management issues been considered for action at future projects?		

Source: DTI, 2004

Appendix 4 - Site Waste Management Plan Data Sheet

Project name	
Project address/location	
Main contractor	
Person responsible for waste management on site (name and job title)	
Person and company completing this form, if different	

Types of waste arising (add more rows if needed):

Material	Quantity (in m³)						
	Re-used on-site	Re-used off-site	Recycled for use on-site	Recycled for use off-site	Sent to recycling facility	Sent to WML exempt site	Disposal to land-fill
Inert							
Active							
Hazardous							
Totals (in m³)							
Performance score as % *							
SWMP Target %*							

**There is an option to develop this form as a measurement tool to evaluate against each waste stream.*

Source: DTI, 2004