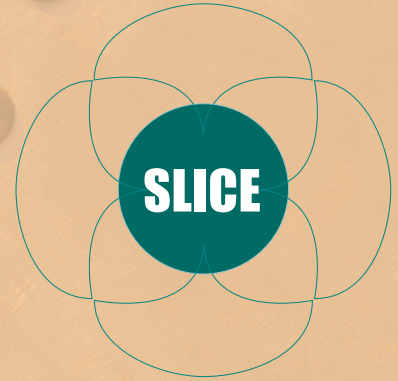


SLICE



Student-centred Learning in Construction Education

SUSTAINABILITY IN CONSTRUCTION STUDENT LEARNING PACKAGE 2

**Steven Goodhew
2003**



Student-centred Learning in Construction Education

Student Learning Pack 2

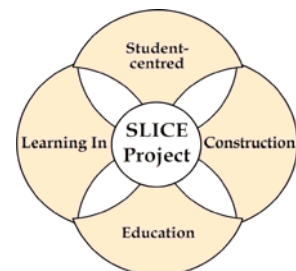
Sustainability and Construction Case Studies and Practicalities



Dr Steve Goodhew

University of Plymouth

2003



Student-centred Learning in Construction Education (SLICE)

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Project aims and outputs

The SLICE project aims to enhance student learning by promoting student-centred learning in Building and Civil Engineering undergraduate education.

The SLICE team have produced a total of nine key outputs each designed to be a practical aid to construction lecturers wishing to develop and/or improve small-scale student-centred learning activities. These outputs include:

- ❖ The SLICE *Handbook on Student-centred Learning in Construction Education* – a comprehensive staff manual on the development of flexible learning materials and activities.
- ❖ Eight subject-specialist Lecturers' Toolkits incorporating ready-to-use learning packs, ideas and resource guides for lecturers. The toolkits cover the following subjects:
 1. Environmental Science
 2. Site Surveying
 3. Building Pathology
 4. Structural Behaviour
 5. Construction Health and Safety
 6. Sustainability in Construction
 7. Quantity Surveying
 8. Water Engineering

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Section

1

Introducing this student-centred learning material

1.1 Aims and objectives

The aim of this material is to enable you to explore a range of issues that relate to sustainable construction.

If you complete this pack you will be able to:

- ❖ demonstrate an awareness of the complexities involved in assessing the sustainability performance of buildings
- ❖ appreciate through case studies how to maximise the sustainability performance of buildings.



Plate 1 The drive towards sustainability should permeate all aspects of the construction cycle

1.2 How you should use this pack

This pack represents 2–3 hours' learning time for you, depending on the depth and extra research that you carry out. In order to gain most benefit, read the material and respond to the questions and tasks as they arise. Use the feedback provided in the Appendix to measure your success and to learn even more.

Obtain one or more of the following texts to supplement your reading.

Anink D et al (2001) *Handbook of Sustainable Building* James and James London

Graham P (2003) *Building Ecology* Blackwell Publishing Oxford

Hagan S (2001) *Taking Shape* Architectural Press Oxford

Lacinski P, Bereron M (2000) *Serious Straw Bale* Chelsea Green Totnes England

Pearson D (1989) *The Natural House Book* Conran Octopus London

Roaf S (2003) *Ecohouse 2, a design guide* Architectural Press Oxford

Smith P (2001) *Architecture in a Climate of Change, a guide to sustainable design* Architectural Press Oxford

Thomas R (1996) *Environmental Design* Spon London

For a selection of useful websites use the SLICE Sustainability Web Directory your tutor should be able to provide with.

1.3 What you should already know

You should already have a general understanding of basic construction techniques for domestic and non-domestic buildings. You should also have some background knowledge of the issues that form the basis of deciding what is sustainable. If you feel you are short of knowledge on any of these points we suggest you obtain/review the following (or similar) texts

Marshall D Worthing D (2000) *The Construction of Houses* 3rd edn Estates Gazette

Chudley R (2001) *Building Construction Handbook* 4th edn Butterworth-Heinemann

Taylor G (2000) *Materials in Construction, an introduction*, 3rd edn Longman

1.4 Can you cheat?

Not really, because there's no point. If you are examined in this topic you will be asked to apply your knowledge using different scenarios to the ones contained here. So if you do not genuinely try to undertake the activities set, you will not learn effectively.

So obviously, if you do decide to cheat in any way you are cheating yourself.

1.5 What support can you expect?

Your tutor will want to provide you with effective support to enable you to complete this material successfully. The kind of support to expect includes:

- ❖ an introduction/induction to the pack and student-centred learning generally
- ❖ perhaps one or two back-up lectures and/or videos to encourage you and enhance your understanding of the topic
- ❖ ongoing tutorial support by way of email discussions, individual and/or group meetings, student peer-group meetings, etc
- ❖ the use of the feedback provided within the material itself.

Do not be shy about clarifying the support you need with your tutor when this material is issued. If you get into difficulty, try to make sure you contact your tutor at the earliest opportunity.

Good luck, we hope you enjoy this student-centred learning pack.

Section**2**

Sustainability: case studies and practicalities

2.1 Introduction

To be labelled a sustainable building, close attention must be paid to the commonly discussed issues of energy, CO₂ emissions, material choice, etc. However, you will also recall that sustainability also encompasses social and economic considerations as well as technical issues (remember the three Es?). Thus, assessing sustainability performance is a complex affair. This module will demonstrate the type of thinking involved when estimating the environmental and sustainability performance of a building. The module considers the performance of buildings and structures under the following headings:

1. The location of a building
2. The structural form/type
3. The use of a building
4. The site practices adopted during the construction process.

2.2 Location

The location of a building or structure impacts strongly on its suitability of use, its economic, social and environmental performance. Explore these issues for yourself by examining the following two case-study dwellings. Then assess how these dwellings perform in the context of sustainability by undertaking Activities 1 and 2.

Example 1

This is a two-bedroom cottage, situated approximately 25 miles from the nearest centre of employment and very close to an area of outstanding natural beauty. The cottage is approximately 150 years old and uses old, partial oil and solid fuel heating systems. The area is renowned for high concentrations of radon gas inside dwellings and can be susceptible to flooding.



Plate 2 Rural dwelling for example 1

Example 2

This dwelling is a two-bedroom flat situated on the third floor of an urban multi-storey residential block. The block was originally built in the early 1960s and although refurbished, has poor standards of insulation. The block is situated within walking distance of a number of employers and is close to local amenities. The surrounding neighbourhood has a higher than average crime level and is quite noisy.



Plate 3 Block of flats for example 2

Activity 1

After examining the case-study dwellings, comment upon the **POSITIVE** aspects that you feel contribute to the sustainability performance of the flat and the cottage based on the criteria listed.

To help you, the 'construction' row has been completed for you.

Features	Comments on cottage	Comments on apartment
Construction	<i>Probably made from local materials, possibly constructed with few man-made materials and so less likely to emit solvents etc.</i>	<i>Small 'building footprint', hence the building takes up less space and can allow higher build densities than other more traditional homes.</i>
Location		
Energy		
Social		

What could be done to these two example buildings that would improve their sustainability despite their built form and location?.

Feedback is provided in the Appendix

Activity 2

After completing Activity 1, comment upon the NEGATIVE aspects that you feel contribute or detract from the sustainability of the flat and the cottage.

To help you, the 'construction' row has been completed for you.

Features	Comments on cottage	Comments on flat
Construction	More maintenance will probably be called for, using up manpower, energy and materials.	Concrete cladding often has a limited life due to carbonation and resultant attack of reinforcement.
Location		
Energy		
Social		

Explain briefly whether it is possible to build a 'sustainable' building no matter where it is located.

Feedback is provided in the Appendix

2.5 Structures

The UK Government's *Strategy for More Sustainable Construction* (DETR, 2000) refers to buildings and structures as the two main outputs of the construction industry. Structures, by way of transport, power, water and land related infrastructure projects, are normally associated with Civil Engineers. Civil Engineers have a special role to play in pursuing sustainable development by:

- ❖ delivering environmental improvements, for example through the provision of clean water, sanitation and the remediation of contaminated land
- ❖ preserving and enhancing appropriate biodiversity
- ❖ providing and maintaining the infrastructure, including power and transport networks, on which a modern economy depends
- ❖ providing a safe, well-designed and built environment in which people are happy to live.

(Source: Society, *Sustainability and Civil Engineering: A Strategy and Action Plan* 2002–3 The Institution of Civil Engineers)



Plate 4 Examples of civil engineering construction infrastructure projects

Civil engineering projects often have a dramatic impact upon our surroundings and use large quantities of natural and man-made materials, labour, machinery and transportation. How can the impact of the construction of a civil engineering structure be minimised? Can a large civil engineering project be built safely, to budget, on time, perform as intended *and embody sustainable construction principles*?

Activity 3 is centred on a modern civil engineering structure, a proposed bridge to provide better links to a rundown urban area. It is hoped the new link will provide improved employment prospects and help regenerate the surrounding area. This activity is limited to the effects and choices concerning the major construction elements and the design of the structure.

Activity 3

Using the four text boxes provided, note the possible impacts, both positive and negative of this proposed link over the river to the previously mentioned urban area.

The nearby community

The materials for the project



Plate 5 Bridge construction

The river water, wildlife and flow

The earthworks and landscaping

Feedback is provided in the Appendix

'Sustainable construction' principles might help to reduce these impacts. A sustainable construction approach can provide responses to many of the negative aspects of a construction project, offering improvements such as:

- ❖ reduced landfill quantities due to increased recycling of waste materials
- ❖ reduced transportation distances through the use of local suppliers
- ❖ better systems to manage site practices and their impacts efficiently (ie waste production, noise pollution, safety, etc)
- ❖ less incidents of environmental degradation and pollution.

Such measures have the added benefit of promoting a better public image of the construction industry through environmental improvements.

2.6 Social housing

The construction industry helps to shape many peoples lives. Infrastructure, transportation, clean water and flood defences all have dramatic impacts on the quality of living and on commerce in the UK. Housing is an important aspect of our standard of living and is also a significant sector of construction output. Social equity is one element of the triple bottom line (the three Es) of sustainable development. Social housing in the UK accounts for approximately 2.5 million homes (comprising 1.5 million dwellings provided by councils or housing associations and one million households in privately owned homes). Thus the construction industry has a strong role to play in promoting social equity through the development of good social housing. The Deputy Prime Minister, John Prescott, has indicated that over a 7–10 year period, all social housing tenants should have a decent home. So what does this mean for the promotion of sustainable construction?



Plate 6 Social housing must be 'people focused' to be successful

Undertake Activity 4 to help you understand some of the important attributes of sustainable social housing.

Activity 4

Using the issues in the left column identify the actions needed to help match any demands that stem from those issues.

To give you a 'head start', the first action, connected with access, has been completed.

Sustainable housing issues	Action required Building Regulation
Allow access by people with mobility problems (social responsibility)	<i>Adopting the access principles set out in Part M as a minimum standard and encouraging better standards.</i>
Affordable heating (social responsibility and reduces energy use)	
Good insulation from the cold and noise (contributes to affordable warmth, reduces energy use)	
A healthy, habitable space (contributes to a safe environment)	
No harmful effects from materials and appliances (reduces environmental impact)	
Real and perceived security within and around homes (social responsibility)	

Can you suggest any further major issues that you would deem necessary to ensure successful social housing?

Feedback is provided in the Appendix

2.7 Site practices

“Most people working in the construction industry could, using a little common sense, write down a list of the main environmental effects (of construction).” (Environmental Management in Construction, Chartered Institute of Building (CIOB), 1996)

Do you think the CIOB are right? Knowledge about sustainability must have improved since 1996, so the statement may be truer now than when first published. However, ignorance and apathy are still major obstacles.

A range of new legislation and environmental management standards has been published to improve the environmental performance of the construction process. These standards include ISO 14000 environmental management series, which replaced the UK-based British Standard 7750. Good management is important; however, improvements require a holistic change in the culture of on-site construction practices. The significant environmental effects of construction practice generally include:

- ❖ water and land pollution
- ❖ air pollution
- ❖ noise
- ❖ vibration
- ❖ light and visual impact
- ❖ purchase and use of services
- ❖ purchase and use of materials
- ❖ waste.

Every construction project is unique, with a different team, different location and often involving different technologies. Consequently, the environmental impacts of construction need to be reassessed for each project. The construction team, both main contractor (site and head office) and subcontractors, need ‘brainstorming sessions’ to make sure that the potential obstacles to minimising environmental impact are identified. Examples of questions that should be asked are:

- ❖ How often does the negative impact occur?
- ❖ What control can the site team exercise over this negative impact?
- ❖ Is there a statutory requirement?

❖ Can the negative impact be measured?

ISO 14000 and similar management schemes require construction businesses to develop a formal process to identify and manage these impacts. If you wish to research ISO 14000 further, try the guide to ISO 14000 at <http://www.iso14000-iso14001-environmental-management.com/>.

Activities 5 to 8 will enable you to consider many of the practical problems faced by construction professionals as they grapple with improving the environmental performance of construction projects. To undertake these activities, imagine that you have been asked to take over the management of an existing inner-city construction site. (This site happens to be a building site; it could easily be an infrastructure site.)

Now, see how many potential solutions you can identify to minimise the adverse environmental effects arising from images accompanying each activity. If you feel there are further improvements to the site's processes that may not stem from the image, feel free to suggest those too.

The case study site relating to Activities 5 to 8 is illustrated below.

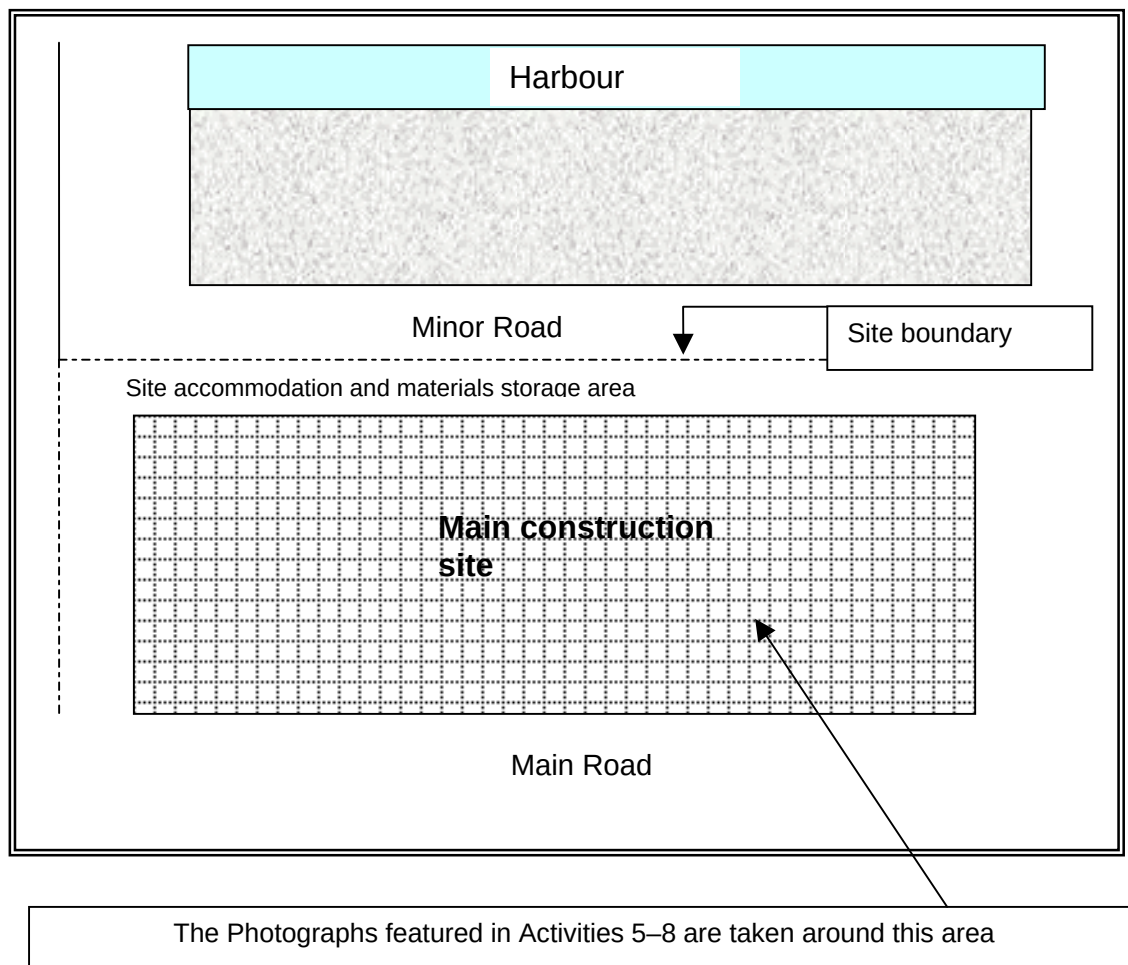


Figure 1 Diagram of site layout for Activities 5 to 8

Activity 5

Examine Plate 7 and the diagram of the site layout. What negative environmental impacts can you identify that relate to the visual impact and use of space around the site?



Plate 7 Visual impact and use of space

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins or other markings visible.

Feedback is provided in the Appendix

Activity 6

Examine Plate 8 and the diagram of the site layout. What negative environmental impacts can you identify that relate to noise and dust on this site?



Plate 8 Noise and dust

[illegible]

Feedback is provided in the Appendix

Activity 7

Examine Plate 9 and the diagram of the site layout. What negative environmental impacts can you identify that relate to the issues of waste and site organisation around the site?



Plate 9 Waste and site organisation

[illegible]

Feedback is provided in the Appendix

[illegible]

Examine Plate 10 and the diagram of the site layout. What negative environmental impacts can you identify that relate to the issues of air and water pollution around the site?



Plate 10 Air and water pollution

[illegible]

Feedback is provided in the Appendix

2.6 Summary

Sustainability is becoming an increasingly important aspect of construction industry activity. This module has helped to demonstrate the complexities of reviewing and assessing sustainability performance. By undertaking the various activities, you have related practically what sustainability means to the construction industry.

The move towards a more sustainable construction industry requires a complete shift of culture, based on the development of knowledge and understanding of the problems we collectively face. The interaction of the environmental, economic and social equity aspects of construction need to be understood well by all parties to the construction process.

The practice of sustainable thinking is constantly evolving, and it is only through the practice of sustainability that anything will become lasting. So keep up-to-date!

2.7 Further reading

Here is a selection of texts that you might find useful

Text	Comment
Abley I and Hertfield J <i>Sustaining Architecture</i> Wiley Academy, Chichester (2001)	Merges case studies, such as The Eden Project, Cornwall with other contributions. The influence of 'rethinking construction' can be seen
Boulevard N and Steemers K <i>Energy and the Environment in Architecture</i> Spon, London (2000)	A technical design guide, based upon the Cambridge 'LT' method, 2.1

Dawes K <i>The Technology and Ecological Buddy</i> Birkhauser Velog, Berlin (1994)	Explains the philosophy of ecological building
Edwards B, <i>Rough Guide to Sustainability</i> RIBA, London (2001)	A no-nonsense guide to sustainability
Edwards B <i>Green Buildings Pay</i> Spon, London, (1998)	A series of studies that explore the production of sustainable patterns of development
Edwards B <i>Towards Sustainable Architecture</i> Butterworth, Oxford (1996)	Sets out the story behind sustainable architecture
Farmer J <i>Green Shift</i> 2nd edn Architectural, Oxford (1999)	Puts 'green thinking' in context
Hawkins D <i>The Environmental Tradition</i> Spon, London (1996)	A series of studies showing the development of environmental design in architecture
Jones DL <i>Architecture and The Environment</i> Lawrence Kay, London(1998)	Forty buildings that exemplify the best in environmental architecture
Maldonado E <i>Environmentally Friendly Cities</i> Lisbon, Portugal, Jones and Jones, London (1998)	A discourse focusing upon quality and the building environment on an urban scale
Prasal RS and D <i>Global Warming and the Built Environment</i> Spon, London (1996)	Offers solution for those concerned with the effect of the building environment upon global warming
Scott A <i>Dimensions and Sustainability</i> Spon, London (1998)	A review of contemporary ideas and innovations
Stenar C, <i>Eco-Tech Sustainable Architecture and Technology</i> Thames and Hudson, London (1997)	An international survey of environmentally intelligent buildings of the 1990s

Truelove J and Greer N <i>Hot Dirt and Cool</i> Harper Collins, New York (2001)	24 case studies showing different forms of 'eco' housing
Woolley T, Kimmins S, Harrison R and Harrison P <i>Green Building Handbook</i> , Parts 1 and 2 E and FN Spon, London (1987)	A guide to building products and their impact on the environment. Part 1: Introduction: An essay highlighting important trends in Green Buildings and explaining the rationale and methodology behind the handbook. Part 2: Key to product table, which includes: fencing products, flat roofing membranes, glazing products, electrical wiring, adhesives, straw bale housing, interior decoration, indoor air quality and ventilation.

Appendix

Activity feedback and solutions

This feedback is intended to provide you with possible responses to the activities presented to you and to extend your learning.

Feedback for Activity 1

After examining the case-study dwellings, comment upon the **positive** aspects that you feel contribute to the sustainability performance of the flat and the cottage based on the criteria listed.

Features	Comments on the cottage	Comments on the apartment
Location	Probably in an area with good air quality, except perhaps if it is near extensively farmed land.	Near to amenities, low travel costs.
Construction	Probably made from local materials, possibly constructed with few man-made materials and so less likely to emit solvents etc	Small 'building footprint', hence the building takes up less space and can allow higher build densities than other more traditional homes.
Energy	High thermal mass may help lower bills in summer.	Up-rated heating and the many shared walls and floors/ceilings reduce heating usage.
Social	Rural communities can be supportive.	Close to many social amenities

What could be done to these two example buildings that would improve their sustainability despite their built form and location?

Cottage:

with likely solid walls, only floor and loft insulation.
More efficient heating system, condensing oil boiler, assuming there is no gas supply. Try to work at home via the net or perhaps car share if public transport is not viable.

Flat:

investigate very efficient thin insulation for the external walls. When internal fittings and finishes need replacing try to select low-odour water-based products and paints. Use a high-efficiency low-power fan/filter systems to ensure better-quality air and to reduce noise, especially in the summer months.

Feedback for Activity 2

After completing Activity 1, comment upon the **negative** aspects that you feel contribute or detract from the sustainability of the flat and the cottage.

Features	Comments on the cottage	Comments on the flat
Location	Distance from employment means that unless 'tele' or home working is possible, commuting is likely.	If driving is contemplated, then occupants are likely to encounter congestion and pollution.
Construction	More maintenance will probably be called for, using up manpower, energy and materials.	Concrete cladding often has a limited life due to carbonation and resultant attack of reinforcement.
Energy	Inefficient heating systems used.	Inherent poor insulation of external walls difficult to improve without reducing internal floor area
Social	Isolation	Noise, crime, sometimes less supportive communities.

Is it possible to build a sustainable building no matter where it is located?

Good question, perhaps some locations will never be as sustainable as others. More conducive, people-friendly, high-density developments may be the answer. Perhaps if you would like to know more, try typing 'sustainable-cities' into a search engine.

Feedback for Activity 3

Using the four text boxes provided, note the possible impacts, both positive and negative of the proposed link over the river to the previously mentioned urban area.

The nearby community

There are many potential benefits for the social side of the sustainability. Mostly continued employment because of the regeneration of the area. Downsides include the possibility of increased noise, pollution, etc.

The materials for the project

Both concrete and steel have large amounts of embodied energy within them. Steel and concrete can, however, have a large recycled content, and if detailed correctly have a long life span.

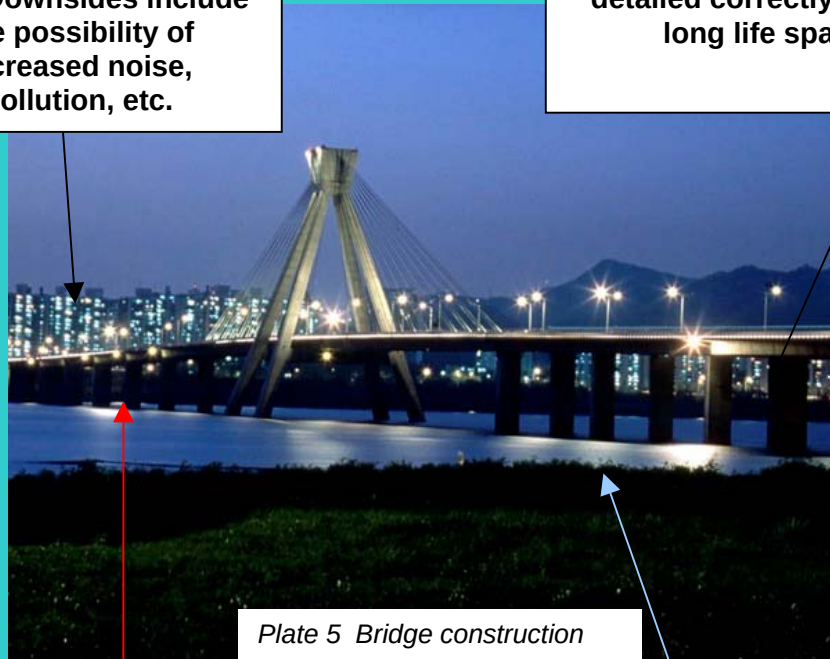


Plate 5 Bridge construction

The river water, wildlife and flow

Bridges and elevated decking supports can have adverse effects upon shipping movements and influence the passage of sediments and so affect aquatic life. Site practices and vehicles can cause pollution in the watercourse.

Earthworks and landscaping

The embankments and paving for junctions, paths etc will disturb virgin ground unless the site is brownfield/previously occupied. Fill may have to be imported or disposed of depending upon the quality and type of ground in the area of the abutments.

Try also to consider the potential impact of the construction of another example of infrastructure. What would be the impacts of the construction and use of new reservoirs, tunnels, bypasses, rail links, tramways, etc?

Feedback for Activity 4

Using the issues in the left column identify the actions needed to help match any demands that stem from those issues.

Sustainable housing issues	Building Regulation/Action required
Allow access by people with mobility problems	Adopting the access principles set out in Part M as a minimum standard and encouraging better standards.
Affordable heating	Adopting efficient heating systems combined with co-ordinating passive principles.
Good insulation from the cold and noise	Appropriate use of low thermal conductivity, high thermal mass and sealing technologies.
A healthy, habitable space	Appropriate ventilation systems combined with materials that do not release volatile organic compounds.
No harmful effects from materials and appliances	Use non-polluting materials and low emission appliances.
Real and perceived security within and around homes	Fit basic security devices as standard. Five-level locks on windows, tamper-proof glazing systems to site dwellings with appropriate visibility cover. The appropriate planning of open spaces to minimise vandalism, joy riding. Define spaces to encourage ownership and responsibility

Are there any further major issues that you would deem necessary to ensure successful social housing?

Many other issues could be deemed necessary but most have less direct connection with sustainable construction than the others named above. The lack of good-quality affordable amenities has been the cause of many social housing projects failing. Keeping the young and the old alike 'connected' possibly via youth clubs or day clubs, will give any new or refurbished area an identity. This is only one 'extra' issue. I am sure you can think of many more.

Feedback for Activity 5

What negative environmental impacts can you identify that relate to the visual impact and use of space around the site?



Plate 7 Visual impact and use of space

As is evident from this image, construction sites can have a significant visual impact. Striking colours can be necessary for safety but may not help the site to 'blend in'. You may have noted the visual impact of the tower crane! Does the crane or any other intrusive plant need to be on hire for any longer than necessary? (The obvious financial benefits are normally also welcome.) Does the crane need to be floodlit? In this case the outer hoarding is relatively subtle, sometimes the company logo can be very intrusive.

The use of space, such as parking (the parking area can be seen in other images and on the site arrangement), large vehicles blocking exits, materials edging out onto public rights of way, can be disturbing to local people. This can be the case even if the appropriate permits have been sought from the local authority.

Feedback for Activity 6

What negative environmental impacts can you identify that relate to noise and dust on this site?



Plate 8 Noise and dust

Many site operations create noise and, in the summer months, dust. Diesel-engine plant on site and lorries that deliver materials off site are one of the main causes of noise and dust. The use of impulsive operations such as concrete breaking, piling and the use of percussion devices to fix materials, exacerbate any disturbance. If the site is to be more sustainable, time limits can be imposed on noisy operations. (This may be imposed by applicable environmental legislation anyway.) A more recent model of the plant being used, perhaps the forklift in the image, could be hired as these are often quieter than older versions. Rather than relying on shouting, the banksman or driver in the image could use agreed hand signals or preferably two-way radio communication if any materials are being unloaded directly off the lorry.

Feedback for Activity 7

What negative environmental impacts can you identify that relate to the issues of waste and site organisation around the site?



Plate 9 Waste and site organisation

Of all the on-site environmental effects, the waste of materials is probably the most visible. Waste, particularly the waste that you can see in this image has implications for safety, another part of applying sustainable construction on site.

This image shows large quantities of materials laying around in a disorganised way. This situation is likely to increase wastage.

Perhaps in your new role you should organise the storage of materials, both waste materials and materials that are waiting to be used.

Recycling does not appear to be a priority on this site! Maybe some clearly labelled skips and the use of an outside contractor, who will brief the workforce about the best way to sort materials for recycling, will help.

Feedback for Activity 8

What negative environmental impacts can you identify that relate to the issues of air and water pollution around the site?



Plate 10 Air and water pollution

Air pollution can come in many different forms. Dust from the works that is pictured above is a form of air pollution. Operatives working in non-ventilated spaces and using certain adhesives or solvents can suffer from the effects of indoor pollution. Laying fibre insulation will be hazardous if the correct masks and other equipment are not worn. It is best to undertake a risk analysis based on any data sheets that are supplied by the manufacturers of the materials you are using and ensure that your workforce comply with their recommendations.

Water pollution and water use are often linked with the use of 'wet-trades' such as plastering, screeds and concreting. Limiting the use of wet trades can cut down the water consumption on site and also, in most cases, water pollution. Some site practices can affect water usage and pollution. If dust is a problem in summer, it is normal practice to 'damp down' an area, obviously using more water and possibly causing some run-off. Possibly an occasion where you are 'damned if you do and damned if you don't'.

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