Department for Transport

TAG Unit A3

Environmental Impact Appraisal

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Department for Transport

Transport Analysis Guidance (TAG)

https://www.gov.uk/transport-analysis-guidance-tag

This TAG Unit is guidance for the Appraisal Practitioner

This TAG Unit is part of the family A3 - Environment

Technical queries and comments on this TAG Unit should be referred to:

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1. Environmental Impact Appraisal

1.1 Introduction

1.1.1 Environmental Impact Appraisal is undertaken as part of the transport appraisal process. The objective of the transport appraisal process is to inform the business case for a transport investment proposal. Further information on the transport appraisal process is provided in Guidance for the Technical Project Manager.

1.1.2 This TAG unit provides guidance for appropriately qualified environmental practitioners/topic specialists on appraising the impact of transport proposals on the built and natural environment, and on people. When using the guidance in this TAG unit, environmental practitioners/topic specialists should refer to current European and UK legislation, regulations and policy, and best practice.

1.1.3 This Chapter discusses:

- The need to tailor the level of detail to the stage of development of the proposal;
- The relationship between environmental impact appraisal (as set out in this manual) and environmental impact assessment;
- The differing types of environmental impact and
- Reporting requirements.

1.2 Level of Detail

1.2.1 Appraisal, using the methods set out in this TAG Unit, should be possible at any stage in the development of proposals. At all stages, a proportionate approach should be adopted. Excessive detail should be avoided - the level of detail should be no more than is needed for robust decisions to be taken. As a proposal develops, where a statutory environmental impact assessment is being undertaken, a more comprehensive level of information should become available and a detailed environmental appraisal can be carried out. However, the methods can be applied using what data is available at any stage; where this is less than fully detailed then the limitations of the data should be identified as part of the appraisal process. Sensitivity testing should be carried out, consistent with that for other impacts (see TAG Unit M4 - Forecasting and Uncertainty), with any assumptions clearly stated, and, where appropriate, the 'precautionary principle[1]' should be applied. Increasing confidence can be placed in the results of appraisal as the level of data improves through the development of proposals.

[1] the precept that an action should not be taken if the consequences are uncertain and potentially dangerous

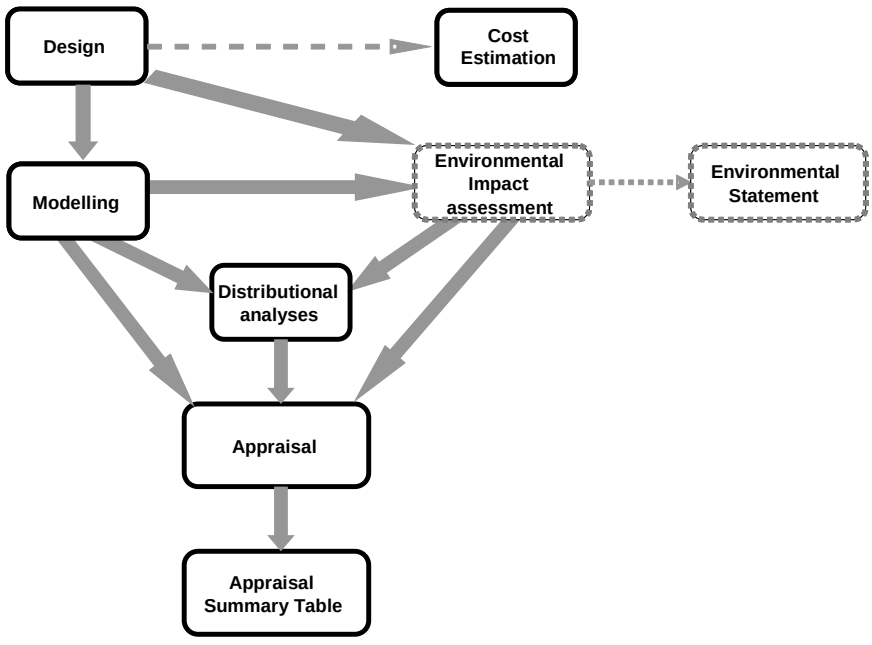
1.2.2 The need for a proportional approach is discussed in more depth in Guidance for the Technical Project Manager, where the requirements for level of detail in appraisal are linked to the stages in the decision making and appraisal processes.

1.3 Relationship with Environmental Impact Assessment

1.3.1 It is important to recognise the distinction between environmental impact assessment and environmental impact appraisal and to appreciate how these two processes should be linked together during the project cycle.

1.3.2 For some projects, there is a statutory requirement to carry out Environmental Impact Assessment, to meet the requirements of the EIA Directive[2]. Other projects do not require statutory Environmental Impact Assessment, but may still require non-statutory environmental impact assessment. The aim of environmental impact assessment, whether it is to meet statutory or non-statutory requirements, is to ensure that the environmental implications of decisions on schemes are made available so that they can inform the design and decision making process.

1.3.3 Guidance in this TAG Unit addresses environmental impact appraisal. This is the process of developing environmental impact information for inclusion in a transport appraisal. This builds on the baseline data and impact assessment work carried out as part of the environmental impact assessment, as the following diagram illustrates. The appraisal recommended in this TAG Unit is not intended to be an alternative to, or a replacement for the environmental impact assessment. Rather, it is intended to complement that work. Where the project delivery programme allows, care should be taken to ensure that the environmental impact appraisal process delivers a message that is consistent with the findings of the environmental impact assessment process.



[2] EC Directive 85/337/EEC as amended by EC Directive 97/11/EC and the Public Participation Directive 2003/35/EC

Figure 1: Relationship between the key components of appraisal work

1.3.4 For highway schemes, comprehensive guidance on environmental impact assessment, whether statutory or non-statutory, is given in **Design Manual for Roads and Bridges, 'Sustainability and Environment**' section (see DMRB LA 101 for overview). DMRB also provides detailed guidance on the methods to be used in the environmental assessment of highway schemes. Much of the guidance set out in DMRB is appropriate for the environmental impact assessment of other transport modes and should be used unless more appropriate alternatives are available. Many of the analyses in this TAG Unit assume that environmental impact assessment consistent with that specified in DMRB is available.

1.3.5 Note that environmental impact assessment (and the DMRB Sustainability and Environment section) covers a wider range of impacts than are discussed in this TAG Unit. Many of those not covered here are covered in TAG Unit A4.1 - Social Impact Appraisal.

1.3.6 The scope of assessment in the environmental impact assessment, and hence the environmental appraisal, is likely to depend on the stage reached in the transport appraisal process. At Stage 1, options generation, environmental impact assessment is likely to be restricted to the scoping stage. Scoping seeks to decide which environmental topics are to be examined in environmental impact assessment and how they should be assessed. Scoping should explore the level of environmental risk associated with options, and should identify potential significant environmental effects. In many cases, this information will be sufficient to enable decisions on which options should be taken forward to Stage 2 and should be recorded in the Option Appraisal Report. Note that, at Stage 1, a spatially detailed transport model may not be available. Where this is the case, the scope for analysis of traffic-related (where traffic may be road or rail) environmental impacts will be restricted.

1.3.7 During Stage 2, further appraisal, environmental impact assessment should proceed through simple and/or detailed assessments (see DMRB LA 101 for an explanation of these terms) as appropriate. A spatially detailed transport model should be available, so that assessment of traffic related environmental impacts can be carried out. The information generated by the environmental impact assessment should be used as the basis for the environmental impact appraisal process, using the methods set out in this TAG Unit.

1.4 Categories of Environmental Impact

1.4.1 In analysing the environmental impacts (which may be both beneficial and adverse), it is useful to be aware that these fall into two main categories:

- those that arise as a result of changes in traffic (whether this be road or rail traffic) using transport infrastructure - noise, air pollution and greenhouse gases; and

- those that arise in the surrounding area as a result of new or improved transport infrastructure and associated development - landscape, townscape, biodiversity, heritage and the water environment.

1.4.2 Those impacts that arise as a result of changes in traffic rely on the existence of a transport model to provide traffic flow data. Those analysing (assessing and appraising) these environmental impacts should liaise closely with those responsible for building and operating the transport model to ensure that the traffic flow data is suitable for their purposes and is provided in an appropriate format.

1.4.3 It is usually not appropriate to consider environmental impacts during, or as a result, of construction. However, there may be circumstances when these impacts are relevant and should be taken into consideration.

1.5 Reporting

1.5.1 Good reporting is a key factor in ensuring that appraisals are transparent and acceptable to decision makers and stakeholders. Reporting should include the following:

- An entry for each topic in the Appraisal Summary Table (AST). General advice on the AST is provided in Guidance for the Technical Project Manager, while guidance specific to each topic is given in the following chapters;
- A worksheet (or worksheets) should be provided for each topic. Worksheets differ from topic to topic – further details are given in the following chapters; and
- Other documentation required to understand the analysis should be provided as required – details are provided in the following chapters.

2. Noise Impacts

2.1 Introduction

2.1.1 For some time the appraisal of noise impacts focused on annoyance. However, there is growing evidence on the links between environmental noise, defined by the World Health Organisation (WHO) as 'noise emitted from all sources except industrial workplaces', and health outcomes. The 2011 WHO report **Burden of disease from environmental noise**[3] identified environmental noise as the second largest environmental risk to public health in Western Europe. Defra has produced guidance on assessing the impacts of transport-related noise from

[3] http://www.who.int/quantifying_ehimpacts/publications/e94888/en/

different sources, covering road, rail and aviation noise, using an 'impact pathway' approach and covering a range of impacts on:

- annoyance,
- sleep disturbance, and
- health impacts, including heart disease (acute myocardial infarction, or AMI) stress and dementia.[4]

2.1.2 Defra's guidance and associated toolkit highlight several key areas of uncertainty in the appraisal of noise impacts. These include the dose response functions that describe how people are affected at different noise levels (such as whether 'High' or 'Moderate' sleep disturbance relationships should be used, and the uncertainties around the odds ratio for AMI impacts[5]); the disability weights used to describe impacts in terms of Disability-Adjusted Life Years (DALYs); and the monetary valuation of those impacts, once expressed in DALY terms. This section describes how noise impacts should be appraised in transport appraisals, based on the central assumptions in Defra's guidance. Where noise impacts are particularly significant, sensitivity testing to reflect these various uncertainties may be required and further advice should be sought from the Department on an appropriate range of sensitivity tests.

2.1.3 Assessing the noise implications of multi-modal transport schemes presents a particular challenge for two main reasons:

- people exhibit different responses to noise from and within different transport modes, making the determination of cumulative impact difficult (this is reflected in the modal variation in dose-response functions and values in Defra's guidance); and
- noise is a local impact which depends on the precise geometric relationship of source and receiver - these may not be sufficiently well defined at early stages of scheme development.

2.1.4 The research carried out by Defra has established monetary values for the 'impact pathways' of noise described above. The inclusion of monetary valuation enables decision-makers to assess the relative importance of the noise impacts of a transport option in relation to other impacts currently measured in monetary terms.

2.2 Methodology

2.2.1 The assessment involves five steps (note that the TAG Noise Workbook automates and combines steps three and four – see section 2.3 below):

- Scoping;
- Quantification of noise impacts;
- Estimation of the affected population;
- Monetary valuation of changes in noise impact; and

[4] https://www.gov.uk/noise-pollution-economic-analysis
[5] http://archive.defra.gov.uk/environment/quality/noise/igcb/documents/project-report.pdf

- Consideration of the distributional impacts of changes in noise.

Scoping

2.2.2 The **first** step, scoping, should be consistent with the scoping of the environmental assessment. The aim of scoping is to decide how noise impacts should be appraised and to define a study area for the scheme that will be applicable to all options. The noise appraisal should be proportional to the scheme and its proposed impact. Analysis should be no more detailed than is required to support robust decision making. The analyses outlined in this Unit may not be appropriate for all schemes, but should provide the basis for less detailed analyses where appropriate. Where noise impacts are deemed to be minimal, the analysis of noise impacts may be scoped out. Where the analysis of noise impacts is scoped out, a comment should be included in the 'key impacts' column of the Appraisal Summary Table (AST).

2.2.3 An important consideration in the scoping stage, given the inclusion of the sleep disturbance impact pathway, is the treatment of noise during the night. For road-based schemes, conversion between different noise measures is considered sufficiently robust for the effects of night time noise on sleep disturbance to be transformed from daytime measures. However, this approach might not always be appropriate, e.g. if a scheme is expected to have significantly different impacts on traffic flows during the day and the night. Therefore, in some circumstances it may be appropriate to scope out night time effects, and in others more explicit modelling of the night time period could be required.

2.2.4 For rail and aviation, similar reliable transformations between day time and night time noise measures are not available. Therefore the scoping should consider whether explicit modelling of night time noise, and assessment of sleep disturbance impacts, would be proportionate given the likely impacts of the scheme.

2.2.5 The scope of the appraisal, including the treatment of night time noise, should be agreed with the Department before a full appraisal is undertaken.

2.2.6 Note that this guidance does not specify any analysis for situations where noise impacts on potentially noise sensitive non-residential receptors such as schools or hospitals. However, where impacts of this kind are likely to be significant, they should be recorded in the 'Key Impacts' column of the Appraisal Summary Table (AST).

2.2.7 For road-based schemes, guidance on scoping the noise environmental assessment is provided in **Design Manual for Roads and Bridges, LA 111, Noise and Vibration** (DMRB LA 111)**.** For other modes, the guidance in DMRB may provide a useful starting point.

Quantification of noise impacts

2.2.8 The **second** step, the quantification of noise impacts, is often carried out as part of the environmental assessment of a project. Noise impact data and other information generated for environmental assessment purposes should be used in the noise appraisal wherever possible. The calculation of noise impacts should be carried out using standard prediction methodologies, such as the Calculation of Road Traffic Noise and the Calculation of Railway Noise.

2.2.9 Ideally, properties should not be double counted during this step in the process. However, little is known about how noise impacts from multiple sources interact and expert judgement is important in these situations. In some cases, 'double counting' could give the best answer. For example, those affected by railway noise may be different from those who would be affected by road traffic noise, or, where noise sources are transient in nature, noise from one source could 'fill the gaps' in the varying noise levels arising from another. For example, a road might affect the front of a property, while a railway line might be to the rear of the same property. Even if the facade noise levels generated by the two sources were similar, as the noise source differs, there is no reason to assume that the resulting impacts would be identical.

2.2.10 Where the levels of noise from different sources are dissimilar, it may be reasonable to make a simplifying assumption and ignore impacts from the source which has less of an impact. However, where there is uncertainty, it is more difficult to make such a simplifying assumption and professional judgement is required to decide how the assessment can be carried out without double counting.

2.2.11 In some cases, property demolitions or house building may alter the number of properties within the study area over time. Where this is the case, this should be reflected in the number of properties exposed to transport noise in the forecast year.

2.2.12 As a general rule appraisers should assume a fixed number of households in both the with scheme and without scheme cases. However, where there are grounds to confidently predict changes in the affected number of households between the without scheme and with scheme cases, this should be reflected in the appraisal. In these cases, a nominal noise exposure of 55dB $L_{Aeq, 16h}$ should be assumed for the missing case, i.e. a demolition will be assumed to lead to the relocated household experiencing 55dB $L_{Aeq, 16hr}$ elsewhere in the with-scheme case, and new homes will be assumed to attract households who would otherwise have experienced 55dB $L_{Aeq, 16h}$ in the without-scheme case.

2.2.13 For road-based projects, guidance on the quantification of noise impacts using the methods set out in the **Calculation of Road Traffic Noise** (DoT, 1988) is provided in DMRB LA 111. Note, however, that DMRB leads to estimates measured in $L_{A10, 18h}$. The results will, therefore, need to be converted to $L_{Aeq, 16h}$ using the following relationship:

$$L_{Aeq, 16h} = L_{A10, 18h} - 2 \text{ dB}$$

2.2.14 Railway noise levels should be calculated using the methods set out in **Calculation of Railway Noise** (DoT, 1995). These are calculated in $L_{Aeq, 18h}$, and Defra recommend that equivalence can be assumed between 'daytime' indicators for rail, so no conversion is required. Modelling aviation noise should be undertaken using the **ANCON model**[6] or a suitable alternative, agreed with the Department. As with rail, for aviation conversion between different L_{Aeq} daytime noise metrics is not required[7].For other modes, the guidance in DMRB may be helpful, but is likely to need to be supplemented by other information and methods.

2.2.15 In most cases, the quantification of noise impacts is likely to make use of information from a spatially detailed transport model (where a spatially detailed model is not available, noise analysts should discuss and agree alternative approaches with the Department). The output from a spatially detailed transport model will enable an understanding to be gained of differences in road traffic flows on a link by link basis throughout the model study area, which in turn will allow differences in noise for specific communities to be predicted. At this level, a detailed understanding of rail movements is also likely to be available. The noise appraisal practitioner should, at an early stage in the study, discuss the information required with transport modelling practitioners to ensure that the transport model study area is compatible with the noise analysis study area and that the model can generate traffic flow information in a format appropriate for noise analysis.

2.2.16 This step should produce cross-tabulations of households experiencing different noise level bands between the with-scheme and without-scheme cases. Analyses should be carried out for the scheme opening year and for at least one other forecast year. The choice of forecast years (other than the opening year) should be consistent with forecast years adopted for modelling and/or environmental assessment.

2.2.17 The noise metric $L_{Aeq, 16h}$ (defined as 07:00 to 23:00 hours) is preferred (as opposed to $L_{Aeq, 18h}$ which has been used previously) as it does not overlap with the L_{night} period (23:00 to 07:00) used in the appraisal of sleep disturbance impacts. As described under step one, appraisal of night time impacts could be on the basis of transformations between day and night time measures (for roads), explicit modelling of the L_{night} period, or scoped out. When included in the appraisal, any significant changes in night noise should be reported in the 'key impacts' column of the Appraisal Summary Table (AST). As well as through the monetisation process described in step three below, night noise impacts should be assessed by determining the number of households where the WHO Interim Night Noise Target of 55 dB L_{night} noise level is exceeded for the last forecast year in the with and without scheme cases. For both road and rail, the night noise assessment should be based on free-field noise levels.

[6] The ANCON model was developed for DfT and is managed by the Environmental Research and Consultancy Department (ERCD) in the CAA. For more detail on the model, see: http://www.caa.co.uk/default.aspx?catid=2832&pagetype=90&pageid=50

[7] For more on conversions between noise metrics, see Defra's noise modelling tool, available at: https://www.gov.uk/noise-pollution-economic-analysis

2.2.18 For schemes at early stages in their development, the location of new infrastructure may not be precisely defined. Where this is the case, the quantified noise impacts for the with-scheme case may be subject to uncertainty. This uncertainty should be taken into account in subsequent stages of the analysis and reported in the Appraisal Summary Table.

Estimation of the affected population

2.2.19 The **third** step, estimation of the affected population, involves calculating the difference in the estimated population who would be affected by noise (for each impact pathway) from alternative sources, comparing the with-scheme and without-scheme cases.

2.2.20 Defra's noise modelling tool contains dose-response functions for each impact pathway, for road, railway and aviation noise. These functions describe, at different noise levels, the percentage of the population affected (for sleep disturbance and annoyance/amenity) or the increased risk of adverse health outcomes (for AMI, stroke and dementia). In combination with information from step two on the numbers of households experiencing different noise levels in the with and without-scheme cases, these relationships can be used to calculate the number of people affected under each impact pathway.

2.2.21 The Defra tool goes on to develop per household, marginal monetary values for each impact pathway. These values are inputs to the TAG Noise Workbook, so that estimation of the population affected for each impact pathway is subsumed within the monetary valuation described in step 4.

2.2.22 The dose-response functions are uncertain at low noise levels (especially over large distances). Consequently, it is recommended that appraisal is undertaken for noise above a threshold below which only a small percentage of the population would be affected. TAG Data Book Table A3.1 and the TAG Noise Workbook provide monetary values from 45dB $L_{Aeq,16h}$ to 81dB $L_{Aeq,16h}$. Although noise levels in excess of this may be experienced road- or track-side, it is unlikely that adjacent properties will be affected by such high noise levels. In the rare case where noise levels exceed the upper limit, the highest monetary values should be used and a comment should be included in the 'key impacts' column in the AST.

2.2.23 The relationships and values in Defra's tool are based on several national average assumptions, such as an average household size of 2.3 to derive per household values. The degree of uncertainty in the noise appraisal will depend on the appropriateness of these assumptions. Where noise impacts are significant, and materially affect value for money conclusions, it might be appropriate to undertake more bespoke analysis of the population affected for each impact pathway.

2.2.24 Note also that the relationships in the Defra tool are based on data gathered in the past decade and further research is needed to assess the response to different sources of transport noise such as: i) high speed rail, which produces a significantly different spectrum of noise than conventional rail; ii) low frequency

noise from light rail systems in urban areas; and iii) noise from road traffic which is not free flowing. This needs to be taken into account, and noted in the 'key impacts' column of the AST, when assessing the noise impact of options which involve non-standard types of rail project or dealing with congested road traffic. Very little is also known about the combined effect of noise from different sources, as one source of noise can mask another.

Monetary Valuation of noise impacts

2.2.25 The **fourth** step, monetary valuation of changes in noise, is based on estimation of the number of Disability-Adjusted Life Years (DALYs) lost (or gained) under each impact pathway, and monetisation with a value of £60,000 per DALY.

2.2.26 Monetary valuation is intended to complement the quantified noise assessment (i.e. the number of households experiencing increases or decreases in noise). It will be used to aid decision-makers when appraising different transport options and raise awareness of the environmental impacts of transport schemes such as noise. Noise valuation should, in general, always be undertaken if a spatially detailed transport model is available. However, uncertainty about the precise location of new infrastructure may introduce significant uncertainty in the noise valuation. Where this is the case, a note should be made in the 'key impacts' column of the AST regarding the approximation.

2.2.27 Valuation is based on the recommendations of the study: **Environmental noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet** (Defra, 2014) and their accompanying noise modelling tool[8]. More detail on the derivation of the values and underlying research is given in that report.

2.2.28 TAG Data Book Table A3.1 shows the annual value of the impact of a 1dB change in exposure to noise at noise levels from 45 to 81 dB $L_{Aeq, 16h}$. These are the standard appraisal values based on Defra's tool and are also the values applied in the TAG Noise Workbook. They should be used with a positive sign to value the benefit of noise reductions and with a negative sign to value the disbenefit of noise increases. Different values are given for road, rail and aviation schemes, based on evidence of how people respond differently to different sources of noise. Values for sleep disturbance are given from 45 to 81 dB L_{night} and, for road only, against $L_{Aeq, 16h}$ as the conversion between these metrics is deemed sufficiently robust for appraisal of sleep disturbance impacts resulting from road noise to be based on changes from daytime measures.

2.2.29 For future appraisal years (i.e. years subsequent to the scheme appraisal year, which is usually set to today), the Green Book discount rate for health impacts should be applied. Historic values, however, should be grown using outturn GDP per capita (as provided in the TAG data book Annual Parameters table)

[8] See https://www.gov.uk/noise-pollution-economic-analysis#noise-modelling-tool

using an income elasticity of 1.3 using the formula below.[9] This is equivalent to assuming per-unit impacts are constant in utility terms. This historical uprating only applies between the value base year (currently 2014 for the noise values) and the scheme appraisal year. This approach is also applied to air quality values, as set out in section 3.4.9.

$$\text{Value}_y = \text{Value}_{base}\left(\frac{\text{GDPpc}_y}{\text{GDPpc}_{base}}\right)^{1.3}$$

2.2.30 Noise benefits should be estimated for the opening year and at least one other forecast year. Benefits should then be interpolated and extrapolated over the appraisal period, and discounted to the Department's standard base year. These manipulations are carried out within the TAG Noise Workbook – see below.

Distributional Impact (DI) analysis

2.2.31 The **fifth** step - Distributional Impact (DI) analysis of noise - should also be scoped and, if appropriate, carried out. The noise appraisal practitioner should liaise with the DI analyst, if applicable, to consider the approach and requirements of a proportionate appraisal of noise DIs. Further guidance on DI analysis is provided in TAG Unit A4.2.

2.3 Using the TAG Noise Workbook

2.3.1 The TAG Noise Workbook automates the valuation of noise impacts. For monetary valuation, noise data is required for both the with-scheme and without-scheme cases in the opening year and the last forecast year. The appraiser will also need to specify the opening year and last forecast year of the scheme and whether it is a road, rail or aviation scheme (as the values vary by mode). The per household values assume an average household size of 2.3, and the user can also specify a different average household size and changes to this over time.

2.3.2 The noise workbook requires a matrix of the numbers of residential properties experiencing without scheme and with scheme noise levels in 3dB $L_{Aeq\ 16h}$ bands. Where night time noise impacts have been scoped in (which should be indicated by selecting 'yes' in the 'Night noise impact' input cell), without scheme and with scheme noise level for 3dB L_{night} bands are also required. The exception is for road-based schemes, where users have the option to apply the transformation between daytime and night time noise measures, so that sleep disturbance values are applied directly to the daytime noise measure. If night time noise data is to be used, users should select 'yes' in the 'Night noise (dB Lnight) modelling' cell. If the transformation from the daytime noise measure is

[9] See Green Book annex 3. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938046/The_Green_Book_2020.pdf. The income elasticity of marginal utility (MU) of income is set to -1.3. If impacts are held constant in utility terms, it follows that their unit monetary values grow in inverse proportion to the MU of income. For example, if the MU of income halves, the monetary value of a unit impact must double. Given the elasticity of MU income is -1.3, it follows that the income elasticity of the monetary value of the good in question is 1.3.

to be used, users should select 'no'. If the available noise data does not meet the requirements of the workbook, please contact TASM for further assistance.

2.3.3 The TAG Noise Workbook applies the Data Book values to the changes in noise levels in the opening and forecast years, to calculate the noise benefit/disbenefit for each impact pathway in each of the two years, in the Department's base year values. The impacts are linearly interpolated between opening and forecast year, and then assumed to remain constant over the remainder of the appraisal period. Real GDP/capita growth is then applied to uprate unit values to the appraisal year, with a 1.5% discount rate (declining at years 31 and 76) applied thereafter. The impacts are adjusted for household size (if an alternative to the default household size of 2.3 has been applied) and discounted to the Department's base year with the Green Book 'health' profile of discount rates.

2.4 Presentation of Results

2.4.1 The output sheet of the TAG Noise Workbook provides a summary of the results generated by the spreadsheet, including the Net Present Value (NPV) of the overall noise impact, and the NPV for each impact pathway separately. If the TAG Noise Workbook is not used, a worksheet providing this information should be provided. This information should be included in the documentation of the noise appraisal work.

2.4.2 Entries in the Appraisal Summary Table (AST) should be as follows:

- The Quantitative column should show the estimated numbers of households facing increases and decreases in noise levels as a result of the scheme in the last forecast year.
- The Monetary column should show the estimated total NPV of the change in noise discounted over the appraisal period.
- The Summary of Key Impacts column should highlight any factors which cannot be readily understood from the numbers in the Quantitative and Monetary columns. For example, there may be a significant impact on night time noise, or instances of properties experiencing noise levels in excess of 80dB $L_{Aeq\ 16h}$. For potential noise insulation issues the number of properties experiencing noise levels that exceed the relevant thresholds in the with-scheme case should be highlighted. Also the appraiser may wish to comment on whether noise impacts on potentially noise sensitive non-residential receptors (for example schools or hospitals) are likely to be significant. An indication can be given of the main factors causing any change in noise conditions.
- The Qualitative column should not be used**.**

2.5 Quiet Areas

2.5.1 In general, noise assessment from transport is limited to the consideration of effects on people in occupied buildings, so-called noise sensitive receivers (dwellings, schools, hospitals etc). The debate on noise impacts stimulated by developing EC noise policy has raised concern about other spaces, particularly

those used for recreation, that currently enjoy a peaceful environment, referred to as 'quiet areas'. Some Member States have become concerned that attempts to improve the noise climate in areas of high exposure may lead to a spreading of noise across areas that are currently almost free from transportation noise. There is a perceived need to protect these quiet or tranquil areas.

2.5.2 However, 'tranquillity' is one of the features defining landscape, and changes in tranquillity will be taken into account in the assessment of landscape impacts. Thus, in order to avoid double counting, the noise impacts of schemes in quiet or tranquil areas should not be assessed under the noise sub-objective.

3. Air Quality Impacts

3.1 Introduction

3.1.1 There are five steps in the appraisal of air quality impacts:

- Scoping;
- Quantification;
- Assessment of impacts (see section 3.3);
- Monetary valuation of (see section 3.4); and
- Consideration of the distributional impacts of changes in air quality (see TAG Unit A4.2).

3.1.2 Guidance in this Unit provides detailed guidance on steps three to five of these five steps - see sections 3.2 to 3.4 below. The remaining steps are discussed briefly below.

3.1.3 The **first** step – scoping - should be carried out consistent with the scoping of the environmental assessment. The air quality appraisal should be proportional to the scheme and its proposed impact. Analysis should be no more detailed than is required to support robust decision making. The analyses outlined in this Unit may not be appropriate in all cases, but should provide the basis for less detailed analyses. Where air quality impacts are deemed to be minimal, the analysis of air quality impacts may be scoped out. The scope of the appraisal should be agreed with the Department before full appraisal is undertaken.

3.1.4 For road-based projects, guidance on scoping the air quality environmental assessment is provided in **Design Manual for Roads and Bridges, LA 105, Air Quality** (DMRB LA 105). For other modes, the guidance in DMRB may provide a useful starting point.

3.1.5 The **second** step - the quantification of air quality impacts – is often carried out as part of the environmental assessment of a project. Information generated for environmental assessment purposes should be used wherever possible. For road-based projects, guidance on the quantification of air quality impacts is provided in DMRB LA 105. For other modes, the guidance in DMRB may be helpful, but is likely to need to be supplemented by other information and methods.

3.1.6 In most cases, the quantification of air quality impacts is likely to make use of information from transport models. The air quality appraisal practitioner should, at an early stage in the study, discuss the information required with transport modelling practitioners to ensure that best use is made of transport modelling capabilities.

3.1.7 The **fifth** step - Distributional Impact (DI) analysis of air quality - should also be scoped and, if appropriate, carried out. The air quality appraisal practitioner should liaise with the DI analyst, if applicable, to consider the approach and

requirements of a proportionate appraisal of air quality DIs. Further guidance on DI analysis is provided in TAG Unit A4.2.

3.2 Overall appraisal approach

3.2.1 Road transport, which is a significant source of $PM_{2.5}$ (Particulate matter less than 2.5µm aerodynamic diameter) and NO_2 (Nitrogen dioxide) in the near locality to the road, is one of the major sources of local air pollution, especially in our towns and cities. In urban areas, emissions from road traffic (for example, cars, buses, lorries and vans), can make a significant contribution to pollutant concentrations. Concentrations of these two pollutants are at the greatest risk of exceeding the UK air quality objectives near major roads, based on the evidence from air quality assessments across the UK. Accordingly, the Local Air Quality analysis focuses on these two pollutants. Many of these pollutants can also travel longer distances, and can have impacts on a regional, national, or international scale. The damage costs provided in the TAG Data Book account for these impacts. For appraisal purposes, currently only nitrous oxide (NO_x), carbon dioxide (CO2) and particulate matter (PM) emissions are valued.[10] Emissions of carbon dioxide are discussed in Chapter 4.

3.2.2 In the first instance, promoters should estimate whether a proposal is likely to result in a breach of legal limits. If so, promoters should consider the potential costs associated with mitigation action designed to ensure legal limits are not exceeded.[11] The next consideration is whether the air quality impacts are likely to have a net present value of greater than £50m. If so, it is recommended to use an impact pathways approach. If below £50m, a damage costs approach is acceptable. In principle, a robustly implemented I-PA is always preferable, and may be necessary in order to capture extremely localised AQ impacts. For example, if traffic is diverted away from a busy street to one with less footfall, individuals' exposures to pollutant concentrations (and hence health costs) may fall markedly yet emissions at the aggregate level may remain largely unchanged. In such cases, a damage costs approach is likely to significantly under-represent represent the true impact.

Damage Costs Approach

3.2.3 For Particulate Matter (PM) damage costs, valuations should be applied to changes in **$PM_{2.5}$ emissions**. Following Defra guidance, in the absence of directly estimated $PM_{2.5}$ emissions, promoters will need to convert estimated PM_{10} emissions into $PM_{2.5}$ equivalent via the conversion factors provided in TAG Data Book table A3.2.3. These have been supplied using NAEI data on estimated ratios of sources of PM emissions between up to 2.5µm and 10µm in diameter. Factors are also provided for non-exhaust emissions.

[10] Defra guidance also contains values for SO2, NH3 and VOC, which may be used. However, TAG does not currently contain guidance on how to incorporate these impacts.

[11] For further detail, see Defra guidance: https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance#working-with-legal-limits

3.2.4 For damage costs regarding nitrous oxides (NO_x), changes in NO_x emissions should be valued. All damage costs are available within TAG Data Book table A3.2.1.

Impact-Pathways Approach (I-PA)

3.2.5 For PM valuation, when using the I-PA, valuation should be applied to changes in **$PM_{2.5}$ concentrations only**. For NO_2, valuation should be applied to changes in **NO_2 concentrations**. Emissions changes (in tonnes) for NO_x will also need to be quantified in order to value the non-anthropomorphic impacts of pollutants. All of the required values are available within TAG Data Book table A3.2.2.

3.2.6 One approach to appraising changes in concentrations, outlined below, is based on a quantification of the change at properties within the vicinity of the transport network. The analysis should be carried out for the scheme opening year and for at least one other forecast year. The choice of forecast years (other than the opening year) should be consistent with the forecast years adopted for modelling. Scheme promoters should refer to the Defra I-PA guidance if they wish to apply an alternative, bespoke approach.[12]

3.3 Assessment of air quality impacts

Approach 1: Assessing changes in concentrations

3.3.1 For most studies, traffic data is likely to be available for individual links in the transport network (where data is not available for individual transport network links, alternative approaches must be used – see Appendix A:) This enables the quantification of changes in concentrations at properties within the vicinity of the transport network as a result of a scheme.

3.3.2 This analysis will produce a value that will define the magnitude of the change in concentrations due to the addition, or removal, of pollution from a specific number of households. The method takes account of all significant changes in concentrations, whether on existing, improved or new routes. A negative value will indicate that there is an overall decrease in concentrations and therefore a general improvement in air quality, due to a scheme. A positive value will indicate there is an overall increase in concentrations and therefore a general detrimental effect upon air quality due to a scheme. Where a scheme will cause a legal limit to be exceeded, mitigating action (and the costs associated with these mitigations) should be considered, in line with Defra guidance. A qualitative comment should be provided on the interaction of the scheme with legal limits and Air Quality Strategy objectives.

[12] https://www.gov.uk/government/publications/assess-the-impact-of-air-quality

Step 1 – Identifying the Affected Network

3.3.3 The first step is to identify the affected network. Affected routes are defined as the existing route, the new route (if the scheme provides one), or an improved route on which traffic flow changes are considered to be significant.

3.3.4 For road projects, the affected roads criteria outlined in DMRB LA 105 for **local air quality assessment**, should be used to determine the study area. This is achieved by comparing the traffic data with and without the scheme case for the relevant forecast year. Using the study area already defined for the DMRB local air quality assessment will minimise the work required for the local air quality appraisal and maximise consistency between the environmental assessment and the appraisal.

Step 2 – Quantifying the Number of Properties

3.3.5 The second step is to quantify the exposure of households to this general change. The most readily available information is the property count. For studies with large numbers of links, using a Geographic Information System (GIS) is recommended, to reduce the time and effort required for this step.

3.3.6 For each affected network link, the properties should be "banded", to take account of the diminishing effects of pollution over distance. The total number of properties within each band should be recorded for the with scheme and without scheme cases. The bands are defined so as to give a close relationship to the diminishing contribution that vehicle emissions make to local air quality with increased distance. The bands are defined as:

- Link centre to 50 m from link centre
- 50 m – 100 m from link centre
- 100m – 150 m from link centre
- 150 m –200 m from link centre

Beyond 200 m from the link centre, the contribution of vehicle emissions to local pollution levels is not significant.

Double counting properties should be avoided. For example, if a property was within 200m of two or more affected links, then the property should be assigned to the nearest identified affected link only.

In most cases, the same number of properties will be calculated for the without scheme and with scheme cases and for all forecast years. However, there may be a change where the area occupied by the carriageway changes, due to properties being demolished or the link centreline moving.

Step 3 – Calculating NO_2 and $PM_{2.5}$ Concentrations

3.3.7 An assessment of annual mean concentrations of NO_2 and $PM_{2.5}$ within each band for all affected routes, is to be made. For roads, the screening method for local assessments described in DMRB LA 105 should be used. Note, however, that the screening method requires adjustment to correct for biases. If these adjustments are not made, a comment should be provided in the 'Key Impacts' column of the Appraisal Summary Table (AST).

3.3.8 Annual mean NO_2 and $PM_{2.5}$ concentrations should be calculated for the following distances from the link centre to represent average concentrations within each band (note that these distances have been selected to take account of the non-linear decline in concentrations with distance):

- 20m
- 70m
- 115m
- 175m

3.3.9 If a new route is being assessed, then NO_2 and $PM_{2.5}$ concentrations for the without scheme case should be taken to be the same as the background concentration.

Step 4 – Calculating Property Weighted NO_2 and $PM_{2.5}$ Concentrations

3.3.10 For each affected link for the without scheme and with scheme cases, the pollutant concentration at the specified point in the band should be multiplied by the number of properties within that band to give property weighted concentrations.

3.3.11 This should be carried out for each of the four bands and the results added together to give a total for the without scheme case and the with scheme case for each affected link.

3.3.12 To calculate the link score for each affected link, the without scheme value should then be deducted from the with scheme value and the score, expressed either as positive, negative or no change.

3.3.13 The link scores for each affected link should then be added together to provide the overall score for the scheme. A positive value should be assigned where an overall increase in concentration has been identified due to the proposal. A negative value should be assigned where there is an overall decrease in concentrations. A zero value indicates no change in pollutant concentrations due to the proposal.

Step 5 – Calculating the Number of Properties that Improve, Worsen or Stay the Same

3.3.14 For each of the affected links, identify the link score. Where the link score is positive assign the total number of with scheme properties to the worsen group. Where a link assessment score is negative assign the total number of with scheme properties to the improvement group. No change should be allocated to the neutral group.

3.3.15 This should be repeated for each affected link, and a running total of properties maintained for each group.

3.3.16 If a property is demolished as part of the scheme, that property should be included in the improvement group, whereas any property constructed as part of the scheme should be included in the worsen group.

TAG Local Air Quality (LAQ) Workbook

3.3.17 The TAG LAQ Workbook has been created to allow the user to easily enter all the information required to complete steps 4 and 5 of the appraisal.

3.3.18 The user needs to enter the corresponding property counts and NO_2 and PM_{10} concentrations for each of the affected links (up to a maximum of 4,500 links) for without scheme and with scheme cases.

3.3.19 The spreadsheet has been developed to link the property count data with the pollutant concentrations for each link. To ensure that the spreadsheet works correctly the corresponding data must be entered into the same corresponding row in both worksheets. Please do not leave any gaps in the data or the spreadsheet will not work correctly.

3.3.20 The property count information for without scheme and with scheme is entered in the 'Property Count' worksheet. The worksheet has been set up so that the user enters the individual link name and the corresponding property counts for 0-50m, 50-100m, 100-150m and 150-200m, without scheme and then with scheme along the same row.

3.3.21 The 'Concentrations' worksheet allows the user to enter the link name and NO_2 and $PM_{2.5}$ concentrations for the without scheme and with scheme scenarios. The entered concentrations correspond to the values calculated in Step 3 for 20m, 75m, 115m and 175m.

3.3.22 Clicking the compile button on the 'Property Counts' worksheet will generate all the worksheets for each affected link and summary worksheets aggregating the results for all the affected links for NO_2 and $PM_{2.5}$.

3.3.23 Examples of a Single Link and Summary Worksheet (the worksheets shown below are for $PM_{2.5}$ but similar worksheets should be produced for NO_2).

Worksheet 1a Local Air Quality – Single Link

PM2.5, ROUTE 1. Route name:	**0-50m (i)**	**50-100m (ii)**	**100-150m (iii)**	**150-200m (iv)**	**0-200m (v=i+ii+iii+iv)**
Properties (amin)					0
Properties (asome)					0
PM2.5 concentration at average point within band for *do-minimum* (bmin)	At 20m:	At 70m:	At 115m:	At 175m:	**N/A**
PM2.5 concentration at average point within band for *do-something* (bsome)	At 20m:	At 70m:	At 115m:	At 175m:	**N/A**
Do-minimum PM2.5 assessment (c = amin*bmin)	0.00	0.00	0.00	0.00	Total route assess PM2.5 (I): 0.00
Do-something PM2.5 assessment (c = asome*bsome)	0.00	0.00	0.00	0.00	Total route assess PM2.5 (I): 0.00
Net total route assessment for PM2.5 (II-I)	0	0	0		0.00

Worksheet 1b Local Air Quality – Summary

PM2.5, SUMMARY OF ROUTES: THE AGGREGATED TABLE	**0-50m (i)**	**50-100m (ii)**	**100-150m (iii)**	**150-200m (iv)**	**0-200m (v=i+ii+iii+iv)**
Total properties across all routes (min)	0	0	0	0	0
Total properties across all routes (some)	0	0	0	0	0
Do-minimum PM2.5 assessment across all routes	0.00	0.00	0.00	0.00	Total assessment PM2.5 (I): 0.00
Do-something PM2.5 assessment across all routes	0.00	0.00	0.00	0.00	Total assessment PM2.5 (II): 0.00
Net total assessment for PM2.5, all routes (II-I)					0.00
Number of properties with an improvement					***0***
Number of properties with no change					***0***
Number of properties with a deterioration					***0***

Approach 2: Assessing changes in emissions

3.3.24 The appraisal of the impact of a transport scheme on emissions of NO_x and PM is discussed below. These method aims to value the overall change in emissions between with and without scheme cases.

Identifying the affected network and the change in emissions

3.3.25 For roads, the regional assessment method outlined in DMRB LA 105 is recommended for quantifying the impact of a transport scheme.[13][14] The first step is to identify the affected roads. The criteria for regional assessment set out in DMRB LA 105 may be used, but it may be more efficient to use the criteria used for the local air quality analysis. Non-exhaust emissions should also be quantified. Up to date factors for non-exhaust PM emissions are available in the TAG Data Book, table A3.5, for this purpose. They are expressed in terms of PM_{10} so will need to be converted to $PM_{2.5}$ using the conversion factors, also available in the TAG Data Book, table A3.2.3.

3.3.26 Once the affected road network has been identified, the regional worksheets of the DMRB LA 105 air quality spreadsheet may be used to complete the necessary calculations. Total emissions for the affected network should be calculated for the with and without scheme cases in the scheme opening year and in at least one other forecast year. As for local air quality, the choice of forecast years (other than the opening year) should be consistent with the forecast years adopted for modelling.

3.3.27 If a scheme is likely to result in an exceedance of legal limits, mitigating action should be factored into the appraisal, including the costs of these mitigations. Defra advises[15] that the do-something emissions should be the level of emissions after the mitigation has been put in place.

3.3.28 Should an appraisal require consideration of emissions exceedances, depending on whether detailed information on traffic flows and air quality is available, **Appendix** B: presents two methods for identifying NO_x emissions where the NO_2 limit value is exceeded. The recommended approach is a detailed, link-by-link method which considers the location and magnitude of exceedances. An alternative, higher-level approach can be used where the detailed information required for the link-by-link method is not available (for example when appraising national policies).

Rail impacts

3.3.29 In terms of total transport emissions, rail transport accounts for less than 1% of the total. Therefore, even with the most rail orientated transport schemes, perhaps doubling the rail kilometres, the potential for any significant impact on

[13] Promoters could also use NOx and PM emission curves published in table A3.5.

[14] https://www.standardsforhighways.co.uk/search/10191621-07df-44a3-892e-c1d5c7a28d90

[15] https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance#working-with-legal-limits

emissions will lie mainly with the saving in emissions from road transport brought about by modal transfer, rather than those generated by rail. It is suggested that emissions from rail sources can be scoped out in most cases. One exception is rail electrification schemes where the estimated reduction in emissions is a large justification for the scheme and extra consideration should be given in these cases. Similarly, where schemes involving rail perform similarly in terms of their total road traffic emissions alone, emissions from rail should be included in the total and used as a determining factor.

3.3.30 Using DfT transport statistics (DETR, 1999) and information from the National Atmospheric Emissions Inventory, a generic emission factor for all rail types for NO_x (as NO_2) of 89g/km has been derived. This includes a contribution from both electric and diesel trains. More specific emission factors are available for diesel trains, which are generally more efficient at converting fuel into useful energy than electric trains. Where schemes are likely to affect mainly diesel trains, the emission factors for diesel trains shown in Table 1 can be used to calculate more accurately the total emissions from rail.

Table 1 Summary of Rail Emission Factors

Diesel Locomotive Type	Power Cars/Train (most frequent number per train)	NO_x Range[(a)]	NO_x Factor[(b)]
Passenger DMU	1 - 6 (2)	12 – 31	40
Passenger HST 125	2 (2)	-	97
Passenger Loco	1 (1)	-	64
Freight	1 - 4 (1)	51 – 170	170

(a) Grams per kilometre per powered car.
(b) Gram per kilometre per train, based on likely powered cars per train - this factor can be varied if details are known.

3.3.31 However, in the absence of any data to enable a more accurate figure to be determined, NO_x emissions from diesel can be taken to be in the order of 80 grams per kilometre per train.

3.3.32 The TAG Air Quality Valuation spreadsheet includes default percentages of rail NO_x emissions in areas exceeding EU limit values required for monetisation while the TAG Data Book, table A3.2.1, contains a breakdown of damage costs for rail by area type.

3.3.33 The fifth step in air quality assessment is monetary valuation of changes in air quality. Air quality impacts should be valued using a hybrid approach which combines the methodologies of damage cost and impact pathway approach (I-PA), developed by the Inter Departmental Group on Costs and Benefits (Air Quality).

Reporting the change in either NO_2 concentrations or NO_x emissions

3.3.34 The damage cost method will provide estimates of NO_x emissions on links exceeding the NO_2 limit value for the without scheme and with scheme cases.

The final part of this step of the analysis is to calculate the change in emissions, by subtracting the without scheme NO_x emissions from the with scheme emissions, on links where the NO_2 limit value is and is not exceeded. Similarly, for the I-PA, we calculate the change in NO_2 assessment scores by subtracting the without scheme score from the with scheme score. As for local air quality, a positive result reflects a worsening of air quality, while a negative value represents an improvement. The results of the analysis should be summarised in **Error! Reference source not found.**, below, which is generated by the Air Quality Valuation spreadsheet. Qualitative comments should include a description of how changes in emissions in areas exceeding limit values have been calculated.

Worksheet 2 Regional Air Quality

Worksheet 2 - Regional Air Quality

Option name Insert intervention name Opening year 0 Forecast year 0

		Without intervention		With intervention		Change in emissions	
		Opening year	Forecast year	Opening year	Forecast year	Opening year	Forecast year
NOx emissions in tonnes per year	Links not exceeding limit values	0.0	0.0	0.0	0.0	0.0	0.0
	Links exceeding limit values	0.0	0.0	0.0	0.0	0.0	0.0

Qualitative comments:

Data Sources:

3.4 Monetary Valuation of Changes in Air Pollution

Damage costs

3.4.1 A TAG Air Quality Valuation Workbook has been developed alongside this TAG Unit to facilitate the necessary steps for calculating the monetary values for air pollutants.

3.4.2 In line with the principles described in TAG Unit A1.1 – Cost Benefit Analysis, analysts should enter the scheme opening year (to determine the appraisal period), forecast year (for interpolation and extrapolation over the appraisal period) and the current year when the appraisal is being undertaken (to determine the correct profile of discount rates when calculating net present values

3.4.3 All of the damage costs required to value air quality impacts are included in the TAG Data Book Table A3.2.1. Further, damage costs for NO_x and $PM_{2.5}$ in £ per tonne are broken down into mode-specific impacts and area type. Scheme promoters should include the scheme type to apply the correct damage costs if applying the damage costs approach.

3.4.4 For cases where concentration based I-PA is used, NO_2 and $PM_{2.5}$ concentrations costs in £ per capita per 1µg/m³ change are also provided. Other

impacts, reflecting non-anthropomorphic costs such as ecosystem damages are valued in £ per tonne and should be measured in changes of NOx emissions. These should then be applied to the overall score for the scheme as reported in the TAG LAQ Workbook.

3.4.5 The valuations are based primarily on the health impacts of air quality pollutants.[16] They are derived from analysis by IGCB(A) of the typical health, environmental and economic impacts arising from changes in pollutants. The high and low values represent uncertainty around the different impact pathways. A detailed derivation is contained within Defra's Impact Pathway Approach guidance. Estimates based on this range should be reported in the appraisal as a sensitivity check.

Using the valuation workbook

3.4.6 For NO_x, the total emissions in the without scheme and with scheme cases for the opening and forecast years (resulting from the regional assessment) should be entered in the "NO_x emissions section".

3.4.7 Emissions on links exceeding the NO_2 limit value should be entered in the "Exceedances" section of the Inputs sheet. Where the link-by-link method has been used, the "custom" option should be selected in the drop-down box and the profile of emissions calculated following the process described above should be entered in row "Custom" across the appraisal period. In cases where no exceedances have been identified, "Custom" should be selected and left blank. If emissions exceedances have not been explicitly modelled link-by-link, typical profiles by Road Transport category and by Rail are provided until 2030. These provide an approximation using Defra's Pollution Climate Mapping (PCM) model of percentage of emissions on links in exceedance rather than more accurately percentage of emissions in exceedance. These represent also only modelled links in the PCM and therefore represent the Strategic Road Network rather than the whole network. As a result, local air quality modelling to identify exceedances is preferred when proportionate to do so. The workbook will then automatically calculate using the profile of emissions where the NO_2 limit value is and is not exceeded for the appraisal period, and apply the appropriate damage costs.

3.4.8 For $PM_{2.5}$, the $PM_{2.5}$ assessment score and estimated emissions for the without scheme and with scheme scenarios should be entered into the "Emissions and concentrations" sheet for the opening and forecast years. Emissions in the with and without cases should also be entered to calculate other impacts. For PM emissions, the with and without cases for the opening and forecast years should be entered in the "Emissions and concentrations" sheet measuring only in $PM_{2.5}$ or PM_{10} for the full change. When using PM damage costs promoters should note, when using PM_{10}, damage costs are converted automatically to $PM_{2.5}$ emissions based on the scheme type and year.

[16] The impacts also include ecosystem damages and productivity effects of pollution exposure. Latest guidance is found here: https://www.gov.uk/government/publications/assess-the-impact-of-air-quality

3.4.9 The spreadsheet linearly interpolates and extrapolates the changes in emissions and concentrations over the appraisal period and calculates the value of changes in air quality, incorporating real changes in the values between the base year and scheme appraisal year, using the same formula for noise values as shown at paragraph 2.2.29 above. Values in future years are held fixed on a per unit basis, for all pollutants: for NO_x and PM emissions, as well as for NO_2 and $PM_{2.5}$ concentrations. The TAG Data Book Annual Parameters Table contains the appropriate growth factors.

3.4.10 The values calculated for each future year are then discounted at the HM Treasury Green Book health discount rate, starting at 1.5%, with real unit values held fixed at their appraisal year level. As set out in TAG Unit A1.1, a discount rate of 3.5% is applied to **all** impacts (including health impacts such as air quality) between the scheme appraisal year and the discounting base year (currently set to 2010). This is then summed over the appraisal period, to give the net present value (NPV) of the change in air quality for the scheme in question. In addition to the primary output of the central NPV values, the high and low NPV values are also calculated by this spreadsheet, for the purposes of sensitivity analysis.

3.4.11 In exceptional circumstances, NO_x emissions or changes in NO_2 concentrations and either the overall score for the scheme for $PM_{2.5}$ concentrations might only be estimated for one year (the opening year). In such cases the opening year emissions and assessment score should be applied to each year over the appraisal period[17]. However, this will provide an approximate estimate only as it does not take any account of future changes in variables including vehicle emission standards, traffic flows, and the number of households located near links. Therefore, this approach is not recommended.

3.5 Presentation of Results

3.5.1 The analyses of impact on local air quality, regional air quality and the economic valuation of air pollution all result in Summary Worksheets. These worksheets should be included in documentation of the air quality appraisal work.

3.5.2 The central monetary estimate for the changes in air quality, estimated using the methodology described in section 3.4 above, should be recorded in the Monetary column of the Appraisal Summary Table. The monetary valuation should be presented as a Net Present Value (NPV), calculated using the methodology provided above. Net Present Values for change in emissions (for NO_x and $PM_{2.5}$) or for change in concentrations (for NO_2 and $PM_{2.5}$) should be reported separately and as a total Net Present Value for change in air quality. A positive value represents a benefit – an improvement in air quality.

3.5.3 In addition to the monetary valuation of air quality impacts, the quantitative assessments of air quality impacts in the opening year, estimated using the

[17] In the spreadsheet this can be done by selecting a nominal forecast year within the appraisal period and entering the opening year emissions and assessment scores against both the opening and forecast years.

methods outlined in sections 3.2 and 3.3 above, should be reported in the Quantitative Assessment column of the Appraisal Summary Table.

3.5.4 Finally, a comment should be provided in the Summary of key impacts column of the Appraisal Summary Table to support the assessments. If any properties are demolished or constructed as part of the scheme, then this should be noted here. If any legal limits or Air Quality Strategy objectives are predicted to be exceeded or an exceedance is removed due to the scheme, then this should be noted here also, along with any mitigation actions factored into the appraisal to reduce or avoid exceedances. In particular, a comment must be provided if the scheme affects air quality within an Air Quality Management Area and state what the effect is.

3.5.5 Note that the Qualitative column should not be used**.**

Table 2 Example of presentation of results in the appraisal summary table

Impacts	Summary of key impacts	Quantitative	Qualitative	Monetary	Distributional
Air Quality	Overall there is a net improvement in local air quality with the scheme, but there is a negative impact on regional emissions for NOx. The scheme does not result in any exceedances	**Emissions** NO_X: +10.5 tonnes $PM_{2.5}$: +0.5 tonnes	N/A	Value of change in NO_X emissions: NPV: £Xm Value of change in $PM_{2.5}$ emissions: NPV: £Xm Total value of change in air quality: £Xm	Moderate beneficial for most vulnerable groups

4. Greenhouse Gases

4.1 Introduction

4.1.1 The Climate Change Act, as amended in 2019, commits the UK to Net Zero by 2050. The original act, passed in 2008, committed the UK to an 80% reduction of greenhouse gas (GHG, shorthand: 'carbon') emissions by 2050, compared to 1990 levels.[18] To drive progress towards this target, the Act introduced five-year Carbon Budgets, which define the emissions pathway to the 2050 target by limiting the total carbon emissions allowed in each five-year period.

4.1.2 The first five Carbon Budgets cover the periods 2008-2012, 2013-2017, 2018-2022, 2023-2027 and 2028-2032. They require carbon emissions reductions of 23%, 29%, 35%, 50% and 57% respectively below 1990 levels, in line with the recommendations of the Climate Change Committee. In April 2021, the sixth Carbon Budget was announced, amounting to an emissions reduction of 78% on 1990 levels over the years 2033-2037. It is expected that further Carbon Budgets will be announced in the future. Each sector must play its part in taking action to achieve these budgets.

4.1.3 It is therefore important that the impacts of proposed transport schemes on greenhouse gas emissions over their whole lifecycle – whether they result in increases or decreases in emissions during these periods – are incorporated within appraisal in a consistent and transparent way.

4.1.4 The monetary value of the impacts of proposed transport schemes on carbon emissions over their whole lifecycle should also be calculated. When carrying out monetary valuation, it is important to distinguish between the emissions from those sectors that are included within the UK Emissions Trading System (UK ETS) – the 'traded sector' – and those that are not – the 'non-traded sector'. The traded sector covers emissions from power and heat generation, energy-intensive industry, some aviation and electricity production consumed in transport. The non-traded sector covers all other carbon emissions and therefore includes tailpipe emissions from the consumption of other types of transport fuel, including petrol, diesel and gas oil.

4.1.5 Inclusion in the traded sector caps relevant emissions and creates a market for them. The cost of any permits to cover traded emissions will be reflected in the purchase price of traded sector goods. Since the purchase price is used in transport appraisal, the cost of the relevant permits will be included in the cost benefit analysis.

4.1.6 Appraisal should consider all greenhouse gas emissions, including those resulting from the production of materials used in any infrastructure, for example cement, steel etc (otherwise known as capital carbon), as well as those

[18] The base year is 1990 for carbon dioxide, nitrous oxide and methane, and 1995 for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.

resulting from changes to the use of transport fuels. The majority of such capital carbon emissions are likely to be covered by the UK ETS.

4.1.7 Any change in carbon emissions due to a transport intervention should be valued using carbon appraisal values provided in TAG Data Book Table A3.4, irrespective of whether the emissions are "traded" or "non-traded".[19]

4.1.8 To avoid double-counting, the valuation of "traded" carbon emissions should include appropriate adjustments to exclude any portion already accounted for within carbon pricing regimes such as the UK ETS. For adjustments applied to emissions covered by the UK ETS, it is recommended to use DESNZ traded carbon values for modelling purposes published in TAG Data Book Table A3.4.2.[20] Adjustments for sensitivity analysis may be informed by values outside the range of the DESNZ traded values with appropriate justification.

4.1.9 Adjustments required for traded emissions under the scope of other (non-UK ETS) carbon pricing schemes should be informed by carbon price data from reliable sources and supported by reasonable assumptions. Analysts should exercise caution and judgement when using any single source of carbon price data. Where schemes are expected to impact traded emissions under multiple carbon pricing schemes, analysts should refer to mode-specific appraisal guidance. For example, additional relevant guidance for aviation scheme appraisal is provided in TAG Unit A5.2.

4.1.10 Where capital emissions are not covered by the UK ETS, e.g. imported materials from countries with no carbon pricing or emissions from the transport of waste and materials to and from sites, they should be considered and valued within the appraisal where it is considered feasible to do so. Where it is not possible to obtain the necessary appropriate data or assumptions for valuing traded sector emissions outside the scope of the UK ETS, these emissions should be valued without an adjustment.

4.1.11 The global warming potential of carbon emissions is measured in terms of the equivalent amount of CO_2 that would give this warming. The standard unit of account is tonnes of carbon dioxide equivalent (tCO_2e), and this is how estimates of carbon emissions should be presented.

4.1.12 The guidance below assumes that greenhouse gas impacts are measured in tonnes of carbon dioxide equivalent (tCO_2e). Note that, before November 2011, TAG guidance assumed greenhouse gas impacts were measured in tonnes of carbon equivalents. Carbon equivalent emissions can be converted to carbon dioxide equivalent emissions by multiplying by the conversion factor of 44/12 based on the relative molecular mass of carbon dioxide relative to carbon. This means 1 tonne of carbon emissions is equivalent to approximately 3.67 tonnes of carbon dioxide emissions.

[19] For further details, see DESNZ carbon valuation guidance: https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal.

[20] These values were originally published by DESNZ in November 2023: https://www.gov.uk/government/publications/traded-carbon-values-used-for-modelling-purposes-2023/traded-carbon-values-used-for-modelling-purposes-2023.

4.1.13 The rest of this chapter is structured as follows. Section 4.2 provides the four-step process for appraising the impact of schemes on GHGs. Section 4.3 highlights the appraisal of GHG impacts in TUBA and the TAG Greenhouse Gases Workbook, while Section 4.4 sets out how GHG impacts should be reported and presented.

4.2 Methodology

4.2.1 A four-step process is needed to carry out the appraisal of the impacts of a scheme on GHGs:

- Scoping;
- Estimation of changes in energy consumption;
- Estimation of changes in emissions of carbon; and
- Monetary valuation of changes in carbon.

4.2.2 The energy consumption and emissions calculations should be done for the project opening year and at least one other forecast year. The choice of forecast years (other than the opening year) should be consistent with forecast years adopted for modelling and/or environmental assessment. Interpolation and extrapolation techniques should be used to extend estimates of the change in carbon dioxide equivalent (CO_2e) emissions across the whole appraisal period. TAG Unit A1.1 - Cost Benefit Analysis describes the factors that should be considered when interpolating between modelled years and extrapolating beyond the last modelled year. It is important that the assumptions used to extrapolate and interpolate modelled estimates of the change in emissions across the whole appraisal period are consistent with those used for other economic benefits (e.g. changes in vehicle operating costs).

Scoping

4.2.3 The **first** step, scoping, should be consistent with the environmental assessment. The carbon appraisal should be proportional to the scheme and its proposed impact. Analysis shall be sufficiently robust to support decision making. It is recommended that whole life carbon assessments are undertaken for schemes. The scope of the full appraisal should be agreed with the Department before it is undertaken.

4.2.4 For road-based schemes, standards on scoping the carbon environmental assessment is provided in Section 3 of LA 114 of the Design Manual for Roads and Bridges. For other modes, the guidance in DMRB may provide a useful starting point.

Estimating the impact of the transport scheme on energy consumption

4.2.5 The **second** step of the process is to assess the impact of the proposed scheme on energy consumption. Carbon emissions are assumed to be

proportionate to the number of litres of fuel burnt or the number of kilowatt-hours (kWh) of electricity used, with different rates for different fuels and vehicle types. This means that, for both the 'with scheme' and 'without scheme' cases in each year, the analyst first needs to estimate fuel and electricity consumption, distinguishing between petrol, diesel, road electricity, gas oil (for rail use), and rail electricity.

4.2.6 The amount of fuel consumed, and therefore the amount of carbon emissions per vehicle kilometre varies considerably by vehicle type. Therefore, for both road and rail schemes, predictions of emissions will be more accurate the more disaggregated is the data on traffic flow by vehicle type. For example, for rail, data disaggregated by individual train types will lead to more accurate estimates of emissions. Similarly for roads, more disaggregated data on traffic flow by vehicle type (e.g. car, light goods vehicle, rigid HGV, articulated HGV and coaches/buses) will lead to more accurate estimates. Grossly aggregated data can lead to significant errors and expert opinion may be required in order to determine the validity of any conclusions drawn from numerical differences in calculated emissions.

4.2.7 **For road transport**, fuel and electricity consumption is estimated using the formula and parameters given in TAG Data Book Tables A1.3.8 and A1.3.9. The amount of fuel consumed by different vehicle types - expressed in litres (or kilowatt-hours) per kilometre travelled - is approximated as a function of average speed in kilometres per hour (km/h).

4.2.8 DfT has developed recommended energy consumption rates (by stock type) for use in appraisal of **rail schemes**. These can be accessed by contacting the Department. Diesel consumption rates should be uplifted over time to account for the expected increase in use of biofuel, using the rates provided in TAG Data Book Table A1.3.10. Should practitioners decide to use alternative assumptions, the supporting written documentation should report the rates adopted and make clear the business case impact of not using DfT's recommended values.

Estimating the impact of the transport scheme on greenhouse gas emissions

4.2.9 The **third** step of the process is to assess the impact of the proposed scheme on carbon emissions. Where possible, this should include emissions over the whole project lifecycle.

4.2.10 It is important that the impacts of proposed transport schemes on greenhouse gas emissions over their whole lifecycle are incorporated within appraisal in a consistent and transparent way. To support the consideration of schemes' WLC impacts, it is recommended that, where feasible, proportionate whole life carbon assessments are conducted in accordance with the principles of the PAS 2080 framework, which are elaborated further in the RICS professional statement Whole life carbon assessment for the built environment (2nd ed., 2023).

4.2.11 The whole life carbon (WLC) impacts of a scheme include **capital carbon** (emissions associated with scheme construction), **operational carbon**

(emissions associated with scheme operation and maintenance), and **user carbon** (emissions associated with scheme users, such as changes in emissions due to mode shift).

4.2.12 Please note that the level of detail and data required in a WLC assessment should be commensurate to the development stage of a project. In addition, undertaking a WLC assessment should not by itself change the economic appraisal period chosen for a scheme, and there is no need to appraise residual GHG impacts at the end of the appraisal period for schemes where asset demolition and removal is expected to fall under the purview of a successor project. The Department should be contacted with any queries regarding WLC assessments.

4.2.13 The fuel/electricity consumption estimated from the second step should be converted into carbon dioxide equivalent (CO_2e) emissions. This is calculated by multiplying by the quantity of carbon dioxide equivalent (CO_2e) estimated to be released from the consumption of one unit of fuel/energy using the relevant marginal emissions factor given in TAG Data Book Table A3.3, Carbon dioxide equivalent emissions per litre of fuel burnt/kWh used. This table provides marginal emissions factors for petrol, diesel and electricity for road use and gas oil and electricity for rail use. The emissions factors include nitrous oxide (N_2O) and methane (CH_4) emitted as well as carbon dioxide (CO_2).

4.2.14 Marginal emissions factors for petrol, diesel and gas oil reflect the blending of biofuels into transport fuel. The Renewable Transport Fuel Obligations order 2007 (RTFO) came into effect in April 2008 and requires fuel suppliers to ensure that by 2014, 4.74% of their total aggregate fuel sales for UK road transport is made up of renewable fuels (blended into road transport fuel and gas oil). Therefore, it is estimated that the introduction of biofuels will result in a reduction in the grams of CO_2e released per litre of fuel burnt.

4.2.15 The emissions factors provided in TAG Data Book Table A3.3 are on a consumption basis, not a lifecycle basis. In other words, they do not currently include emissions from the production or processing of biofuels. Biofuels are considered to produce zero emissions when combusted, as the carbon released in combustion is offset by the carbon absorbed as the biofuel feedstock was grown. Emissions relating to the production and processing of biofuels are usually attributed to the agricultural and industrial sectors and vary widely from fuel to fuel. For this reason, the emissions factors currently only cover the combustion stage of the biofuel lifecycle, where emissions are zero.

4.2.16 The energy content of biofuels is lower than for conventional fuels, so a greater volume of fuel will be needed to travel the same distance as the blend of biofuel increases. This effect is taken into account in the assumed vehicle fuel efficiency values given in TAG Data Book Table A1.3.11.

4.2.17 The electricity emissions factors are based on the most recent release of BEIS guidance available at the time of the definitive release of this unit). For electricity used as road transport fuel, in electric cars, for example, the relevant emissions factor is the long run marginal emissions factor for domestic consumption. For electricity used in rail, the generation based marginal

emissions factor uplifted by 1.5% is used. The 1.5% uplift is the estimate of the distribution and transmission losses in the supply of electricity to the rail network (AEA, 2007).

4.2.18 Having calculated the carbon dioxide equivalent (CO_2e) emission levels for each year, the change between the 'with scheme' and 'without scheme' cases for each year can be calculated. Carbon dioxide equivalent emissions from the traded sector will need to be calculated separately from carbon dioxide equivalent emissions in the non-traded sector. For example, CO2e emissions for electric vehicles need to be reported separately from petrol and diesel vehicles, as electricity emissions are in the traded sector.

4.2.19 Where a scheme impacts upon emissions from more than one transport mode, the net change in carbon dioxide equivalent (CO_2e) emissions for impacts on each mode should be estimated. That is, the difference between the sum of emissions from each mode in the 'with scheme' case and the sum of emissions from each mode in the 'without scheme' case should be estimated for each year.

Monetary valuation of greenhouse gas impacts

4.2.20 The **fourth** step is to apply monetary values to the estimates of changes in carbon emissions. The Department for Energy Security & Net Zero (DESNZ) publish guidance on the valuation of greenhouse gas emissions for policy appraisal. This sets out the methodology for carbon valuation in UK policy appraisal based on the estimated abatement costs per tonne of carbon dioxide equivalent to achieve the government's emissions targets.

4.2.21 Where impacts are in the **non-traded** sector (petrol, diesel and gas oil emissions), they are to be valued using the values given in **TAG Data Book Table A3.4, £ per Tonne of CO_2e**, which are based on those referred to in the DESNZ guidance. These values are estimated by the target-consistent marginal abatement costs consistent with the Government's commitments on carbon emissions. The values will be updated periodically to reflect updates published by DESNZ. Higher and lower estimated values are provided for sensitivity analysis.

4.2.22 The value per tonne of CO_2e emissions, which varies for each year, should be applied to the difference in emissions in each year. This should then be discounted at standard HM Treasury rates (see TAG Data Book Table A1.1.1) and summated to give the NPV of the change in non-traded sector fuel consumption related CO_2e emissions over the appraisal period. A positive number would suggest there has been an overall reduction in CO_2e emissions and conversely a negative number would suggest that there has been an overall increase in CO_2e emissions.

4.2.23 For transport appraisal purposes, estimates of monetised carbon impacts based on the appraisal values in TAG Data Book Table A3.4 should be assumed to reflect the "factor cost" unit of account, following the explanation of appraisal units of account in TAG Unit A1.1: Cost-Benefit Analysis. Therefore, estimates of monetised carbon impacts should be uprated by the indirect tax correction

factor provided in TAG Data Book Table A1.3.1 to ensure comparability with other monetised impacts typically presented in the “market price” unit of account.

4.2.24 Where there are changes to the use of transport fuel that is in the **traded** sector, for example electricity, the changes in emissions should be valued using the carbon appraisal values provided in TAG Data Book Table A3.4 but with an appropriate adjustment for existing carbon pricing mechanisms – refer to 4.1.8 for further details.

4.2.25 To be consistent with the accounting of traded sector emissions across Government, the following approach should be used (again using electricity for illustration)[21]:

- estimate the electricity consumption in the 'with scheme’ and 'without scheme’ cases as discussed in step two above;
- use electricity prices which include the UK ETS allowance price (see TAG Data Book Table A1.3.7);
- account for electricity costs in the 'with scheme’ and 'without scheme’ cases in line with standard guidance, which sets out where such transport fuel costs should feature in the appraisal. See TAG Unit A1.2 – Scheme Costs.

4.2.26 The Department should be contacted with any queries regarding this approach.

4.3 Software

4.3.1 For road and multi-modal schemes using the TUBA program, the net present value of the change in carbon dioxide equivalent (CO_2e) emissions from road-based fuel consumption that is in the non-traded sector will be presented as an automatic output of the program in the Department's standard base year prices and values for the whole appraisal period. Please note that **if TUBA is being used to estimate the change in carbon dioxide emissions it is essential that all 8,760 hours of the year are included and properly represented in the analysis**. Note also that TUBA estimates fuel consumption based on the average speed for an entire journey. In some circumstances, this may result in biases. For more details on TUBA, see the TUBA Manual (Mott MacDonald, 2006). The non-traded carbon dioxide values for the Department's standard base year and the annual growth rate are programmed as default into the TUBA software. The TUBA program also outputs the NPV based on the upper and lower estimates of the carbon dioxide values.

4.3.2 Alternatively, road-based fuel consumption related carbon dioxide equivalent emissions for the 'with scheme’ and 'without scheme’ cases can be estimated using the DMRB LA 105 air quality screening spreadsheet. Note, however, that the screening method requires adjustment to correct for biases. If these

[21] Guidance on the appraisal of GHG emissions associated with aviation schemes and policies is provided in TAG Unit A5.2: Aviation Appraisal.

adjustments are not made, a comment should be provided in the 'Key Impacts' column of the Appraisal Summary Table (AST). **DMRB guidance on carbon is presented in units of carbon equivalent. These must be converted to units of carbon dioxide equivalent by multiplying by a factor of 44/12.**

4.3.3 Where TUBA is not used and for rail schemes, the **TAG Greenhouse Gases Workbook** which accompanies this unit can be used to carry out the monetisation, generating the same outputs as TUBA. **Users of the DMRB spreadsheet can also use the TAG Greenhouse Gases excel spreadsheet to calculate the valuation of the emissions, but it is essential that they check which units are being used (whether carbon equivalent emissions or carbon dioxide equivalent emissions). If the units are carbon equivalent emissions, these must be converted to carbon dioxide equivalent units using the standard conversion factor (44/12).**

4.3.4 Carbon dioxide equivalent emissions in tonnes, split by traded and non-traded sectors, for the 'with scheme' and 'without scheme' cases for each year of the appraisal period should be entered into the TAG Greenhouse Gases Workbook. The opening year of the scheme and the current year of appraisal must also be entered into the spreadsheet.

4.3.5 Internally the spreadsheet then calculates the change between the 'with scheme' and 'without scheme' cases for each year, split by traded and non-traded sectors. These results are then summed over the appraisal period to provide information for reporting purposes.

4.3.6 The spreadsheet then multiplies the change in non-traded and traded sector carbon dioxide equivalent (CO_2e) emissions by the value per tonne of carbon dioxide equivalent emissions for the year in which it is emitted. The value of the change in emissions in each year is then discounted at standard HM Treasury rates (see TAG Data Book Table A1.1.1) to give a net present value in the Department's standard base year of carbon dioxide equivalent emissions for that particular year. This is then summated over the appraisal period, to give the NPV of the change in carbon dioxide equivalent emissions for the scheme in question.

4.3.7 In addition to the primary output of the central NPV value, and in order to inform sensitivity analysis, the upper and lower NPV estimates will also be output from the spreadsheet.

4.4 Reporting Requirements

4.4.1 Greenhouse gas impacts should be reported and presented appropriately to enable decision makers to understand the carbon impacts of transport schemes. The TAG Greenhouse Gases Workbook calculates and summarises monetised carbon impacts, and hence can provide inputs for the Appraisal Summary Table (AST) and the Carbon Summary Table (CST), which synthesise the scheme's key appraisal and carbon information respectively.

The Greenhouse Gases Worksheet

4.4.2 The 'Greenhouse Gases Worksheet 1' that heads the TAG Greenhouse Gases Workbook summarises the analyses outlined above, and the information set out there should be provided for all appraisals, including those not using the TAG Greenhouse Gases Workbook. Promoters who are using the TUBA program should extract suitable information from program outputs in completing the worksheet.

4.4.3 As well as the standard outputs described below, the worksheet enables more detailed information to be documented on assumptions made, sensitivity analysis, and data sources. The worksheet should record the assessment method used, e.g. TUBA, DMRB or other, and whether rail emissions have been taken into account and, where they have, the basis of the calculations. Any uncertainties involved in the calculation of emissions should also be recorded. This worksheet will provide a basis for the required input into the Appraisal Summary Table (AST) and Carbon Summary Table (CST).

The Appraisal Summary Table (AST)

4.4.4 The following describes the information that should be recorded and presented in the AST.

4.4.5 The entry in the "**Monetary**" column of the AST should give the net present value of the monetary value of the total change in the non-traded and traded sector carbon dioxide equivalent (CO_2e) emissions between the 'with scheme' and 'without scheme' cases over the whole appraisal period. A positive value will reflect a net benefit, i.e. there would be a reduction in carbon dioxide equivalent (CO_2e) emissions over the whole appraisal period in comparison to the 'without scheme' case.

4.4.6 The traded sector component of this net present value should include appropriate adjustments to exclude any portion already accounted for within carbon pricing regimes such as the UK ETS, as set out in section 4.1.8..

4.4.7 The entries in the '**Quantitative'** column of the AST should present the total impact on non-traded carbon dioxide equivalent (CO_2e) emissions and (separately) the total impact on traded carbon dioxide equivalent (CO_2e) emissions between the 'with scheme' and 'without scheme' cases for the whole appraisal period (which is the sum of the changes in each year) expressed in units of tonnes of carbon dioxide equivalent (tCO_2e). In this instance, a positive number will suggest an increase in carbon dioxide equivalent (CO_2e) emissions (relative to the without-scheme case), i.e. the scheme has an adverse impact on carbon. Alternatively a negative number will suggest that the scheme tends to reduce carbon dioxide equivalent (CO_2e) emissions from the 'without scheme' case and hence there is a relative improvement in carbon gases.

4.4.8 The '**Summary of Key Impacts**' column of the AST should be used to indicate any special features of the appraisal, along with an indication of the key drivers which are responsible for any change in conditions. Any uncertainties involved in the calculation of emissions should also be identified in this column.

4.4.9 Note that the '**Qualitative'** column should not be used.

The Carbon Summary Table (CST)

4.4.10 Scheme promoters should complete the CST, which further raises the prominence of carbon impacts by providing a standardised format synthesising the scheme's key carbon information.[22]

4.4.11 It includes information about total carbon impacts (in tonnes and monetary terms) and disaggregated carbon impacts (by whole life carbon stage and by traded/non-traded sector) and additional relevant information such as the methodologies used to derive carbon estimates, sensitivity of carbon impacts to key assumptions, and mitigation strategies for reducing scheme emissions.

4.4.12 It also includes three quantitative carbon metrics that help articulate the trade-offs (or co-benefits) associated with the scheme's carbon impacts: the cost effectiveness indicator (CEI), the weighted average cost comparator (WACC), and the carbon efficiency metric (CEM). The TAG Greenhouse Gases Workbook can help compute these metrics.

4.4.13 Scheme promoters should refer to Appendix D: of this unit for more information on how to complete the CST, and compute and interpret the carbon metrics.

Other Reporting

4.4.14 In addition, given the legally binding carbon budgets to which the Government has committed under the Climate Change Act 2008, it is important that appraisals are consistent with cross Whitehall guidance and therefore produce emission figures (expressed in millions of tonnes of carbon dioxide equivalent, $MtCO_2e$) needed for carbon budget accounting and reporting requirements. Therefore the appraisal should also present:

i) The impact on carbon dioxide equivalent emissions relative to the 'without scheme' case in the scheme opening year, reported as a breakdown between the traded and non-traded emissions

ii) The impact on carbon dioxide equivalent emissions relative to the 'without scheme' case in each of the five-year carbon budget periods (2008-2012, 2013-2017, 2018-2022, 2023-2027, 2028-2032 and any additional periods announced in the future), reported as a breakdown between the traded and non-traded emissions.

4.4.15 This information may be obtained from the TAG Greenhouse Gases Workbook.

4.4.16 It should be noted that because most transport energy sources – except electricity - generate carbon dioxide emissions in the non-traded sector, the carbon dioxide equivalent emissions impacts would therefore affect the UK's net carbon account, and hence the need for it to be reported. Where a scheme leads to a change in for example electricity use, then because this is in the

[22] https://www.gov.uk/government/publications/webtag-appraisal-tables

traded sector it would not have an impact on the UK net carbon account. Such impacts should however also be reported because it illustrates the implications for the purchase of UK ETS allowances to cover those emissions. However, as discussed above, traded sector emissions should not be valued and included in the Net Present Value.

4.4.17 For those schemes that reduce emissions, a cost-effectiveness indicator may be required. This is the case if the reduction exceeds a given threshold. There are two separate thresholds to be considered:

- if the stream of CO_2e savings (scheme lifetime less than 20 years) exceeds 0.1MtCO_2e average per year, or

- if the stream of CO_2e savings (scheme lifetime more than 20 years) exceeds 2.0MtCO_2e over the lifetime and exceed an average per year of 0.05 MtCO_2e.

5. The Environmental Capital Approach

5.1 Introduction

5.1.1 The methodology to be used for appraising the environmental topics Landscape, Townscape, Historic Environment, Biodiversity and Water Environment is based on a qualitative 'environmental capital' style approach. This approach was developed by the statutory environmental bodies Natural England (formerly the Countryside Agency and English Nature), English Heritage and the Environment Agency in co-operation with DfT.

5.1.2 More recently, Defra have led in developing an ecosystem services approach to assessing impacts on the natural environment. Box 1 summarises how this compares with the environmental capital approach and some of the challenges in incorporating ecosystem services methods in TAG guidance in the future.

Box 1 The Environmental Capital Approach and Ecosystem Services

Supplementary Green Book guidance (HMT and Defra, 2012) recommends the use of an ecosystem services framework to assess environmental impacts “where there are multiple environmental effects”. This approach focuses on the essential services provided by the environment that underpin people’s economic, social and personal well-being. Ecosystem services are generally classified as provisioning, cultural, regulating or supporting services.

Under the environmental capital approach, capital comprises a set of resources (grouped into the topics Landscape, Townscape, Historic Environment, Biodiversity and Water Environment) which are qualitatively assessed with no explicit distinction between capital stocks and flows of goods or services. Although the classifications and terminology vary, this approach considers many of the same impacts as an ecosystem services approach. The key distinction is that an ecosystem services approach focuses on the services provided by the environment, resulting in a more comprehensive framework and allowing for the possibility of a wider range of impacts being monetised in cost-benefit analysis. Where ecosystem services are widely traded, their monetary values are likely to already be included in cost-benefit analysis. For example, the value of food provisioning services is included in the cost of purchasing agricultural land.

The links between topics in the environmental capital approach and ecosystem services are complex. Some ecosystem services fall across a number of topics and some topics include consideration of a number of ecosystem services. For example, recreational and aesthetic value services could be considered under the Landscape, Townscape, Biodiversity and Water Environment topics and the Biodiversity topic includes consideration of wild species diversity, recreational and water, soil, disease and pest regulation services.

Therefore the environmental capital approach covers many of the impacts that would be analysed using an ecosystem services approach. However, significant further work would be required to fully convert the assessment of these topics to an ecosystem

services approach. Scoping work for the Department has highlighted some gaps that could be filled using an ecosystem services approach with further research. Therefore, in the future and with further research, there is potential to incorporate ecosystem service-based methods in to the environmental capital framework where they would be proportionate and improve the information provided to decision makers.

5.1.3 The appraisal methodologies for each topic are set out in the following Chapters with accompanying Worksheets which should be used to record the appraisal results. This Chapter discusses some of the common issues that arise for these topics.

5.1.4 Note that this and the following five chapters adopt the following terminology:

- The term 'key environmental resources' is used to describe site or location specific resources under each topic that are considered to be of particular value; and
- Each topic is characterised by a number of 'features';

5.2 Scope of the Appraisal

5.2.1 Appraisal, using this approach, should be possible at any stage in the development of schemes from option development to detailed appraisal. At all stages, a proportionate approach should be adopted. Excessive detail should be avoided - the level of detail should be no more than is needed for robust decisions to be taken. As a scheme develops, where a statutory environmental impact assessment is being undertaken, a more comprehensive level of information should become available and a detailed appraisal of the environmental capital and effects on it can be made. However, the approach can be applied using what data is available at any stage; where this is less than fully detailed then the limitations of the data should be identified as part of the appraisal process. Sensitivity testing[23] is encouraged, with any assumptions clearly stated and, where appropriate, the 'precautionary principle' should be applied. Increasing confidence can be placed in the results of appraisal as the level of data improves through the development of proposals.

5.2.2 The process of characterising and appraising environmental topics is important in its own right, and not just as a means to produce the final score which will feature on an Appraisal Summary Table (AST). The methodology and detail provides further information to decision makers, who will often have to look further than the AST and its score in considering the effects of schemes. This work will also provide a clear audit trail setting out the basis for these decisions.

[23] The appraisal process is based on a number of judgemental decisions. In some cases, these decisions will be uncertain. Sensitivity testing should explore the implications of these uncertainties. For example, if there is uncertainty about the severity of an impact on a key environmental resource, sensitivity tests based on alternative levels of severity should be considered. It is important to adopt a proportionate approach to sensitivity testing. Sensitivity testing should focus on those uncertainties that are likely to have a significant effect on the overall assessment score for a topic.

5.3 General Methodology

5.3.1 The methodology for appraising the impact of a scheme on the environmental topics landscape, townscape, the historic environment, biodiversity and the water environment follows a common general approach. Specific considerations for each environmental topic at each stage are described in subsequent Chapters. The generic steps are as follows:

- **Step 1**: Scoping and identification of study area
- **Step 2**: Identifying key environmental resources and describing their features
- **Step 3**: Appraise environmental capital
- **Step 4**: Appraise the proposal's impact
- **Step 5**: Determine the overall assessment score

5.3.2 For road-based schemes, guidance on the environmental impact assessment of each main environmental topic is provided in the Sustainability and Environment section of the Design Manual for Roads and Bridges (DMRB). For other modes, the guidance in DMRB may provide a useful starting point.

Step 1: Scoping and identification of study area

5.3.3 The **first** step, scoping, should be carried out consistent with the environmental impact assessment scoping methodology. Each environmental topic should be scoped separately. The appraisal should be proportional to the scheme and its proposed impact. Appraisal should be no more detailed than is required to support robust decision making. Where impacts are deemed to be minimal, further analysis may be scoped out. The scope of the appraisal should be agreed with the Department before full appraisal is undertaken.

5.3.4 During the scoping step, information should be obtained relating to the potential impacts of the scheme and the area over which they have the potential to be significant. This enables the size of the study area, and the key environmental resources in this area that may be affected, to be determined. This information may be identified during the environmental assessment process. Note that the potential impacts of the scheme and its zone of influence are likely to vary from one environmental topic to another.

Step 2: Identifying key environmental resources and describing their features

5.3.5 'Key environmental resources' is the term used to describe site or location specific elements of the environment that provide qualities and functions which are considered by the community (local, regional, national or international) to be of particular value. Many studies will affect quite large geographical areas. Inevitably, key environmental resources will vary across these large study areas. For example:

- there may be areas of archaeological importance in one part of the study area, and historic buildings in another;

- woodland may be a key biodiversity feature in one location, with wetland being key elsewhere;
- there may be several towns or cities in a study area, each with different townscape character
- there may be several distinct landscape character areas within the study area.

5.3.6 Further variation is likely to arise because the nature of proposals (and hence their impact) may vary across the study area. For example, one part of the study area may be affected by proposals for a guided busway, while a road scheme may be proposed elsewhere.

5.3.7 These variations may be addressed by treating each key environmental resource separately. However, excessive detail should be avoided – the number of key environmental resources identified should be kept to the minimum necessary. The level of detail should be no more than is needed for robust decisions to be taken.

5.3.8 Key environmental resources should be identified on the basis of the coherence of character within each resource and the distinctiveness of character between resources. It is likely that the geographical scale of the resources will vary between environmental topics. For example, key landscape resources will often be large geographic areas, while key biodiversity resources may be quite small. Key environmental resources should not be automatically equated to designated sites.

5.3.9 Identifying key environmental resources in this way enables the analysis (steps 3 and 4 below) for each resource to be carried out relatively easily. These separate assessments must be combined to provide an overall assessment for the option as a whole, suitable for use in the Appraisal Summary Table (AST) – this is discussed in step 5 below.

5.3.10 Once the key environmental resources have been established, the characteristic and locally distinctive features of each resource must be identified and recorded. In addition, any discernible trends which would lead to degradation or loss of those characteristic features in the absence of the proposals should also be identified and recorded. This information provides a baseline description against which the incremental impact of proposals on the key environmental resource can be appraised.

5.3.11 The process of description does not itself make a quality judgement. Quality judgements (that is, appraising the importance of features contributing to the character of the key environmental resource) are made in the subsequent 'capital' step of the appraisal.

Step 3: Appraise environmental capital

5.3.12 The third step uses the concept of environmental capital, to assess what matters and why it is important. Note that it is important to assess what matters and why at present and how that may change over time in the absence of the

proposal. This provides the baseline level of environmental capital against which the impact of the proposal can be appraised.

5.3.13 The environmental capital methodology builds on information about environmental character by using a set of common indicators and definitions to add cultural and subjective values and assess impacts, in order to produce an overall qualitative summary of baseline environmental capital.

Step 4: Appraise the proposal's impact

5.3.14 This step in the approach involves describing and scoring the impact of the scheme on the baseline environmental capital established in the preceding step. The descriptions and scores produced in this step will inform judgement about the overall assessment score. Where a scheme affects a number of key environmental resources within a topic, it's impact on each resource should be assessed separately.

Step 5: Overall assessment score

5.3.15 This step consists of deriving an overall assessment score on the standard seven point textual scale: large/moderate/slight beneficial and adverse, neutral. It will be informed by the baseline environmental capital established at Step 3 and the appraisal of impact carried out at Step 4. The precise approach varies from one environmental topic to the next. In some cases, a systematic approach is recommended, in others the process is more judgemental. Further guidance is provided for each environmental topic in subsequent Chapters.

5.3.16 Where a scheme is under continuing development and refinement, it is possible (or even probable) that the assessment score will change. This may be a result of changes in the scheme, or the agreement of certain mitigation options to moderate any impacts identified at an earlier stage in the development of the scheme.

5.3.17 The scoring categories described for each environmental topic should not be considered as comparable with those determined for other environmental topics, due to qualitative differences between them. It should also be recognised that the definitions are not fixed and finite. Analysts should recognise that the local processes of character description and capital evaluation may switch schemes either way between points on the scale. This open flexibility is necessary to accommodate the complexity of environmental appraisal in general.

5.3.18 Where a scheme affects a number of key environmental resources within a topic, each resource should be assigned an assessment score, based on the baseline environmental capital established at step 3 and the appraisal of impact carried out at step 4 for the resource being considered.

5.3.19 The following guidelines should be used to derive the overall assessment score for a topic from assessments on a number of separate key environmental

resources. The advice here on the accumulation of environmental assessments is intended to provide a transparent and systematic basis for accumulating site or location specific results, while also allowing for the exercise of expert judgement.

- **Most adverse category**. The principle here is that a scheme as a whole should be assessed according to the most adverse assessment of the key environmental resources affected. For example, if a scheme affects, say, five key environmental resources, of which one is in the 'large adverse' category and the remaining four are 'slight adverse', then the overall assessment score should be 'large adverse'. The rationale for this approach is that highly adverse impacts should not be diluted or masked by less adverse impacts. It also encourages the development of alternative schemes which avoid such adverse outcomes.
- **Cumulative adverse effects**. The principle here is that, where it is clear that there is a cumulative effect across a range of key environmental resources, then the scheme as a whole should be scored in a higher category than the key environmental resources in isolation. For example, a scheme may affect a number of key environmental resources, each of which is assessed 'slight adverse'. Where it is clear that there is a cumulative effect across the key environmental resources, the scheme as a whole would be assessed as 'moderate adverse'. The existence of cumulative effects will usually depend on there being some similarity in the characteristic features or attributes of the affected key environmental resources. For example, a group of biodiversity sites might all be habitats for the same species of plant or animal.
- **Balancing adverse and beneficial effects**. The principle here is that, where there is a genuine compensatory effect, adverse assessments on some key environmental resources may be balanced by beneficial assessments on others. However, the precautionary principle is especially relevant here. The key issue is whether there are genuine compensatory effects. In most cases, it will be necessary to consider the impacts on each key environmental resource at a detailed level, to ensure that the features lost from one key environmental resource are provided at another. For example, adverse assessments on groundwater supply at one location would probably need to be offset by beneficial assessments on groundwater supply at another location - beneficial assessments on floodplain would probably not provide genuine compensation. The scope for genuine compensatory effects will often be determined by the substitutability of attributes. In most cases, there is great uncertainty about the scope for substitutability, thus balancing should err on the side of caution. In particular, balancing should be restricted to 'slight' or, exceptionally, 'moderate' assessments. It is very unlikely that adequate compensatory effects can be identified to justify any balancing of 'large adverse' or 'very large adverse' assessments.

5.3.20 Clearly, these guidelines require an understanding of the key environmental resources and the impacts of the scheme on them. In addition, judgement and expertise are required to apply them satisfactorily.

5.4 Reporting

5.4.1 Good reporting is a key factor in ensuring that appraisals are transparent and acceptable to steering groups and stakeholders. Reporting should include the following:

- the assessment of impact for each key environmental resource should be clearly summarised, using the appropriate Worksheet and hence the assessment score on a 7-point scale for each key environmental resource;
- For some schemes, the appraisal may involve a large number of affected key environmental resources. It may, therefore, be helpful to summarise the individual resource appraisals into meaningful groups before determining the overall assessment score.
- a summary list of key environmental resources and their assessment scores should be provided;
- a statement should be provided, explaining how the overall assessment has been derived from the key environmental resource specific assessments and giving particular emphasis to the reasons for any cumulative adverse and balancing effects adopted; and
- in addition to the overall assessment and a qualitative comment, the AST should provide (in the 'Summary of Key Impacts' column) a summary of the numbers of key environmental resources in each scoring category.

5.4.2 Reporting should also state whether features present in the environment are typical of the locality. This provides decision makers with the first step back on the audit trail from the assessment score into the information on which it has been based. It will be informed by the appraisal of impact carried out in step 4 of the process, and by the descriptions given to illustrate and define scores as set out in the 'Definitions of Overall Assessment Scores' tables in each Chapter; however, it should not be a simple and repetitive restatement of that and should also draw on the specific features and their values set out in steps 2 and 3 of the process in order to inform decision makers and any subsequent review of the reasons for arriving at the assessment score. This opportunity to comment will be especially useful in setting out how contrasting impacts on aspects of the environment have been balanced to reach the assessment score derived from the process.

6. Impacts on Landscape

6.1 Introduction

6.1.1 Landscape means more than just 'the view'. It is both the physical and cultural characteristics of the land itself (i.e. its use and management) and the way in which we perceive those characteristics. It is this mix of characteristics and perceptions that make up and contribute to landscape character and give a "sense of place".

6.1.2 Characteristics may be commonplace and make a significant contribution to local distinctiveness and community perception of value, for example the particular form of construction of dry-stone walls in the Cotswolds. They may also be individual, eye-catching and prominent, such as a church spire, or have strong local cultural associations.

6.1.3 It is important to recognise that both the characteristics of the landscape themselves and the way in which we perceive these characteristics may well change over time in the absence of a scheme. As far as possible, any significant changes should be taken into account during the formulation of the baseline against which the impact of a scheme on the landscape is to be appraised.

6.1.4 Note that some schemes, such as a road or rail scheme, will normally be prepared with the concept of 'landscaping' (that is, improving the aesthetic appearance of the scheme by modifying the visible features of the surrounding land) built in as part of aesthetic design and mitigation. It is the schemes thus produced (at successive design stages) which are subject to appraisal of landscape impact.

6.2 Methodology

6.2.1 The methodology for appraising the impact of schemes on landscape follows the five step general approach to appraising 'environmental capital' described in Chapter 5 above. This Chapter provides additional, landscape specific information to be used in steps 2 to 5 of the guidance given in Chapter 5 (there is no landscape specific information for step 1). It refers to **The Landscape Appraisal Worksheet**, which should be completed unless landscape impacts have been scoped out in step 1.

6.2.2 For each key environmental resource (character area – see below), The Landscape Appraisal Worksheet identifies the features Pattern, Tranquillity, Cultural, and Land Cover each of which is described and assessed against the following indicators: Scale it Matters, Rarity, Importance and Substitutability. The impact is recorded in the final column. The assessment score is derived from Table 3 which gives a seven point scale based on the scheme's fit with the

landscape or landform, visual amenity, loss of character, degree of mitigation and effect on policies.

6.2.3 A similar approach to the analysis of landscape impacts is adopted in the Highways Agency's Interim Advice Note (IAN) 135/10. While IAN 135/10 is designed for use on major highway projects, it is likely to be useful for the appraisal of other modes, too.

6.2.4 **Step 2**, Identifying key landscape environmental resources and describing their features, starts from the process for describing 'countryside character'. This is detailed in 'Landscape Character Assessment Guidance for England and Scotland' (LCA), published in 2002 by the former Countryside Agency and Scottish Natural Heritage (SNH). This is a means of systematically recording and expressing the characteristic and locally distinctive features of an area and provides the basis for identifying key landscape environmental resources. The process identifies and describes what currently exists in the landscape and any discernible trends which would lead to degradation or loss of those characteristic features in the absence of the scheme. Other assessment material, such as Area of Outstanding Natural Beauty and county level landscape assessments, should also be used where appropriate. Further guidance on landscape character assessment may be found on Natural England's website, www.naturalengland.org,uk.

6.2.5 Given that 'landscape' is a complex mix of physical features and patterns, and cultural associations, the level of detail to which landscape character assessment and appraisal is undertaken depends very much on the purpose of the exercise and the scale of the landscape in question. Landscape can be systematically classified into a hierarchy of 'types' or 'units', each with a recognisable character. A cascade of sub-divisions down to the local site level can be prepared by this classification. For example, a detailed landscape statement for a proposal would be at a fine local level of detail, having been set within the broad landscape context provided by Natural England's Character Area Framework and then described at subsequent sub-regional, county and local scales. Key landscape environmental resources should be identified using this classification, bearing in mind the need for coherence of character within each resource and distinctiveness of character between resources.

6.2.6 In order to accurately assess the character of a key landscape environmental resource, it is necessary to identify and describe the features of the landscape in the first column (headed **Description**) in the Landscape Appraisal Worksheet. **Features,** for the purposes of this guidance, are the summation of those attributes which most strongly define a key landscape environmental resource and which are directly or indirectly affected by a scheme. Definitions of the features which combine to define landscape are given below.

- **Pattern** - this is the expression of the relationship between topography and form, elevation and the degree of enclosure and scale. For example: "this landscape is characterised by a small scale pattern of fields within an enclosed, narrow upland valley".
- **Tranquillity** - this term means the remoteness and sense of isolation, or lack of it, within the landscape. This can be affected and often determined by

noise levels and visual amenity resulting from the absence of built development and intrusion from traffic.

- **Cultural** - this term should cover descriptions of how landscape elements of an historic or traditional nature contribute to landscape character. These include, for example, built forms and architectural styles, settlement patterns, commons, field patterns, archaeological remains, notable and cherished views and those with strong local, cultural, associations. Description of such characteristics should cross refer to, and help provide the landscape setting for elements of, the historic environment, which will be separately appraised in more detail (see Chapter 8, Impacts on the Historic Environment).
- **Landcover** - it is essential to describe how the way in which the land is farmed or managed contributes to the character of the landscape. The pattern and texture of any landscape will vary greatly depending on whether, for example, arable farming dominates over pastoral or vice versa. The presence of semi-natural habitats and their associated landscape elements should be briefly described here so that cross references can be made to the separate and more detailed appraisal of impacts on biodiversity. If field size was not a relevant characteristic under “cultural features”, it will definitely need to be recorded here. For example: ‘intensively farmed arable landscape of large fields with few hedgerows, most of which are redundant and poorly maintained’. The structural diversity provided by the presence of trees and woods should also be recorded here. For example: ‘woodland is a scarce but prominent element as the woodland blocks are large and regular in shape, whilst most minor roads in the south of the area are characteristically tree-lined’.
- **Summary of character** - this should summarise and pull together the relationship between the primary features of the key landscape environmental resource being appraised. More general observations on the texture and diversity of the landscape, its scenic qualities, degree of development and visual unity or disharmony should be made here. An overview of the visual amenity of the landscape should also be provided here.

6.2.7 **Step 3**, the appraisal of landscape environmental capital, is addressed by four **Landscape indicator** columns in The Landscape Appraisal Worksheet. They should read in sequence, from left to right, to make impact appraisal on each feature straightforward. Each feature should be assessed using the full sequence of indicators to enable a meaningful and accurate impact appraisal to be made. In making these assessments, account will need to be taken of how features may change over time in the absence of the scheme. Definitions for each of the landscape indicators are given below.

- **Scale it matters** - This is about the geographical scale at which the feature matters to both policy makers at all levels and to the local stakeholders (businesses, interest groups, residents, and so on). The scale at which features matter will not necessarily be on the same scale as the feature itself. For example, views across a large scale continuous landscape may matter only for local aesthetic and recreational reasons, albeit to a large number of local communities. Conversely a single, prominent element in the landscape, Glastonbury Tor, for example, will matter at a national scale for a number of reasons.

- **Rarity** - should be interpreted as to whether the landscape features being evaluated prior to impact appraisal are commonplace to the locality or scarce. Rarity often relates directly to importance. For example, lowland heathland may be a commonplace landcover feature of the local landscape at the scheme level but it has high importance and matters at a national scale. Conversely, a small-scale pattern of fields bounded by hedgerows could make an important contribution to landscape character locally, and thus be relatively rare within the landscape at the scheme level, but will be of less than regional importance. Maintaining landscape environmental capital can be as much about safeguarding and keeping the commonplace common as conserving and protecting the rare.
- **Importance** - meaning, how important is this feature and at what level, for example, high, medium, or low and at national/regional/local level and to whom. For example, an individual tree or group of trees may be of very high importance at the local level, both in folklore and as a landscape element framing views of the skyline, but do not figure at a regional or national level. Assessing importance is straightforward where recognised policy judgements about the importance of features (and their associated elements) have been made, for example, it is a recognised feature of Area Of Outstanding Natural Beauty or National Park designation. These are landscapes with a full range of particular qualities and characteristics which make them worthy of national designation. National Parks and Areas of Outstanding Natural Beauty are statutory designations, whereas Heritage Coasts are a national planning designation. There is usually considerable diversity within these landscapes and there may be discordant features which can be identified and raised as objectives for improvements. They are all equal, however, in terms of their very high quality of landscape. However, it must be recognised that the majority of the country comprises undesignated landscapes, which can also be of high quality and of great importance. Assessing importance in these cases will, out of necessity, be both a matter for professional judgement and public perception. The subjectivity of assessing importance is an integral part of environmental management and should not be regarded as a weakness of it. This approach also enables policies with environmental objectives based on quality to be set within the context of character assessment and appraisal.
- **Substitutability** - addresses whether landscape features and their constituent elements are replaceable or not within a given time frame, normally a nominal 100 years. Some elements, however, such as mature trees, would take considerably longer to replace. It may be impossible to replace a rare feature or element within the locality within any conceivable time frame - no other suitable site for lowland heath, for example. Conversely, landscape pattern might be replicated locally through the creation of new hedgerows within 10 to 15 years. Cultural landscapes are intrinsically irreplaceable, although some features of these landscapes are more significant than others and some attributes may be replaceable. The period required for substitution must be considered in relation to the time required for the construction and operational phases of any scheme and the maturation of landscape mitigation measures. Substitution should be interpreted as the replacement of features lost with an acceptable and appropriate substitute, that is, something that provides the same benefits. In the case of landscape the feasibility of substitution of features should be considered on a site-specific basis, that is, is there suitable land available locally to recreate the features being lost or affected.

6.2.8 **Step 4**, appraising the scheme's impact on the landscape, should be summarised in the column headed **Impact.** This column should be used to systematically **describe** and **score** the potential impacts of the scheme on the landscape features. These should have been succinctly described and categorised against the indicators set out above. In assessing impact, the information on **Importance** and **Substitutability** will be particularly relevant. All impacts on the landscape, both adverse (damaging) and beneficial (enhancing) must be identified along with their predicted magnitude. In making these assessments, account will need to be taken of how features may change over time in the absence of the scheme. The significance of each separate impact can then be appraised and scored. Any uncertainties over any of these aspects should be explained. The views of all the relevant authorities, statutory bodies, organisations and local residents should be brought to bear in making a decision as to the extent and significance of the impacts on the character and quality of each landscape feature and its constituent elements. This will be easier where an environmental impact assessment has been carried out. Where such information does not exist it should still be possible, however, to make a preliminary judgement of impacts. It will be critical to the appraisal process to address how the scheme could impact on and change:

- the character of the landscape - effects on the locally distinctive pattern of landscape elements;
- how visually intrusive the scheme could be - potential for effects upon visual amenity within the study area, including effects on key views if appropriate; and
- the tolerance of the landscape being able to accommodate further change.

6.2.9 It is accepted that any scheme will include appropriate environmental design measures proposed as part of the scheme design to achieve best fit within the landscape. The impact of a scheme on the landscape should be judged on this basis. Although inherent environmental design measures within the design of the scheme will ameliorate the impacts on specific landscape features and elements, it may be questionable as to how far such measures can be successfully implemented. For example, off-site tree planting and field wall construction may be largely dependent on agreements with local landowners. Where there is any doubt as to how far such measures can be implemented, this must be made clear in the worksheet, in the Qualitative statement section.

6.2.10 It may also be appropriate to consider whether further, additional mitigation measures should be considered over and above that included in the design of the scheme. This will enable new ideas for mitigation not expressed in environmental assessments to be considered to determine whether all mitigation measures proposed will be:

- beneficial and cause the scheme to enrich and enhance the character of the landscape, or;
- essential to neutralise the impact of the scheme proposed on the character of the landscape, or
- ineffective in reducing/minimising the impact of the scheme.

6.2.11 Where additional mitigation is considered, it should not be considered in determining the overall assessment score as no commitment can be made to its implementation. However, its effect on the impacts of the scheme should be noted in the qualitative statement part of the worksheet.

6.2.12 **Step 5**, determining the overall assessment score, builds on all the information recorded in The Landscape Appraisal Worksheet, using the definitions for overall impact scoring shown in Table 3. To arrive at an assessment score for each key environmental resource (character area) it will be necessary to appraise the significance of each of the individual impact assessments for each landscape feature. An important pointer will be the impact assessment for "summary of landscape character" as this should best indicate how well the scheme would fit with the landscape. However, even when a scheme would fit well with the grain of the landscape, there may be an impact on particular landscape features and elements that could dominate the initial fit. For example, a well-designed scheme that includes environmental design measures could nevertheless, because of the chosen alignment, bisect and fragment the integrity and visual amenity (either close up or far away) of an important and nationally significant landscape element, for example, a listed historic parkland with a distinctive design of woodland planting, or a river corridor as a unique linear feature. This should also cross refer to the impact scores for historic environment and biodiversity appraisal.

6.2.13 The impact on the landscape is summarised using the AST standard seven point scale. In addition, a means of identifying exceptionally severe adverse impacts is provided for by the rating 'Very Large Adverse'. This might be applicable where a scheme impacts adversely on a very high quality landscape (Area of Outstanding Natural Beauty or National Park) or has a very damaging impact on highly important or rare combinations of landscape features and their elements. This rating is not part of the seven point scale - it is intended to highlight impacts which are clear outliers in comparison to those covered by the standard scale.

6.2.14 The nature of the impact (after construction of the proposal and maturation of environmental design measures) for each point on the scale (and for Very Large Adverse) is set out in Table 3 with statements reflecting the appraisal process described in this guidance. These statements are for guidance in determining impacts. For a scheme to qualify for a particular score, most of the statements relating to that score must apply.

6.2.15 Where more than one key environmental resource (character area) has been identified, the guidelines for step 5 given in chapter 5 should be used to derive an overall assessment score to be reported in the Appraisal Summary Table.

Table 3 Landscape: Definitions of Overall Assessment Scores

Score	Comment
Large beneficial (positive) effect	The scheme provides an opportunity to greatly enhance the landscape because • It greatly enhances the character (including quality and value) of the landscape • It creates an iconic high quality feature and/or series of elements • It enables a sense of place, scale and quality to be restored in an area formerly of high landscape quality Note that very few, if any, schemes are likely to merit this score.
Moderate beneficial (positive) effect	The scheme provides an opportunity to enhance the landscape because: • It fits very well with the scale, landform and pattern of the landscape • There is potential, through environmental design measures, to enable the restoration of characteristics, partially lost or diminished as the result of changes resulting from intensive farming or inappropriate development • It will enable a sense of place and scale to be restored through well-designed planting and environmental design measures, that is, characteristics are enhanced through the use of local materials and species used to fit the scheme into the landscape • It enables some sense of quality to be restored or enhanced through beneficial landscaping and sensitive design in a landscape which is not of any formally recognised quality • It furthers government objectives to regenerate degraded countryside
Slight beneficial (positive) effect	The scheme: • fits well with the scale, landform and pattern of the landscape • incorporates environmental design measures to ensure they will blend in well with surrounding landscape • will enable some sense of place and scale to be restored through well-designed planting and environmental design measures • maintains or enhances existing landscape character in an area which is not a designated landscape, nor vulnerable to change • avoids conflict with government policy towards protection of the countryside
Neutral effect	The scheme is well designed to: • complement the scale, landform and pattern of the landscape • incorporate environmental design measures to ensure that the scheme will blend in well with surrounding landscape characteristics and landscape elements

Score	Comment
	• avoid being visually intrusive nor have an adverse effect on the current level of tranquillity of the landscape through which the scheme passes • maintain existing landscape character in an area which is not a designated landscape, that is, neither national or local high quality, nor is it vulnerable to change • avoid conflict with government policy towards protection of the countryside
Slight adverse (negative) effect	The scheme: • does not quite fit the landform and scale of the landscape • although not very visually intrusive, will impact on certain views into and across the area • cannot be completely integrated because of the nature of the scheme itself or the character of the landscape through which it passes • affects an area of recognised landscape quality • conflicts with local authority policies for protecting the local character of the countryside
Moderate adverse (negative) effect	The scheme is: • out of scale with the landscape, or at odds with the local pattern and landform • visually intrusive and will adversely impact on the landscape • not possible to fully integrate, that is, environmental design measures will not prevent the scheme from scarring the landscape in the longer term as some features of interest will be partly destroyed or their setting reduced or removed • will have an adverse impact on a landscape of recognised quality or on vulnerable and important characteristics or elements • in conflict with local and national policies to protect open land and nationally recognised countryside
Large adverse (negative) effect	The scheme is very damaging to the landscape in that it: • is at considerable variance with the landform, scale and pattern of the landscape • is visually intrusive and would disrupt fine and valued views of the area • is likely to degrade, diminish or even destroy the integrity of a range of characteristics and elements and their setting • will be substantially damaging to a high quality or highly vulnerable landscape, causing it to change and be considerably diminished in quality • cannot be adequately integrated • is in serious conflict with government policy for the protection of nationally recognised countryside

Score	Comment
Very large adverse (negative) effect	The scheme would result in exceptionally severe adverse impacts on the landscape because it: • is at complete variance with the landform, scale and pattern of the landscape • is highly visual and extremely intrusive, destroying fine and valued views both into and across the area • would irrevocably damage or degrade, badly diminish or even destroy the integrity of characteristics and elements and their setting • would cause a very high quality or highly vulnerable landscape to be irrevocably changed and its quality very considerably diminished • could not be integrated: there are no environmental design measures that would protect or replace the loss of a nationally important landscape • cannot be reconciled with government policy for the protection of nationally recognised countryside

7. Impacts on Townscape

7.1 Introduction

7.1.1 Townscape is the physical and social characteristics of the built and non-built urban environment and the way in which we perceive those characteristics. It is this mix of characteristics and perceptions that make up and contribute to townscape character and give a 'sense of place' or identity.

7.1.2 The physical characteristics of a townscape are expressed by the development form of buildings, structures and spaces. The development form influences the pattern of uses, activity and movement in a place and the experience of those who visit, work and live there.

7.1.3 The social characteristics of a townscape are determined by how the physical characteristics (i.e. buildings, structures and open spaces) are used and managed. For example, the character and value of a pedestrianised square in a town or city centre is very different to a square that has not been pedestrianised.

7.1.4 It is sometimes difficult to distinguish the boundaries between townscape and landscape and between townscape and historic environment. It is often the success of the interaction between all three that determines how well a place works. The impacts of a transport proposal on all three (landscape, townscape and historic environment) should therefore be appraised, recognising the interplay where appropriate.

7.1.5 On the issue of the boundaries between townscape and landscape, the extent to which impacts are appraised under any one of these topics will depend on the context of the scheme. The approach for townscape does not specify a minimum settlement size to which it should be applied and will depend on the nature of the scheme in question. For example, a junction improvement in a village may well result in townscape impacts.

7.1.6 Townscape differs from historic environment, in that it encapsulates all aspects of the urban form and not just those of an historic nature. Undistinguished modern buildings, for example, with arguably little in the way of current architectural or historic character and value, may still be important in contributing to the distinctive nature of an urban area. For example, the high rise office blocks and modern apartments in London's Docklands give that area a distinctive character and value. However the underlying archaeological and historic framework may partly define and be reflected in the grain of a townscape.

7.1.7 This approach for appraising townscape is analogous to the methodology used for landscape. It incorporates the principles of good practice urban design.

7.2 Methodology

7.2.1 The methodology for appraising the impact of proposals on townscape follows the five step general approach to appraising 'environmental capital' described in Chapter 5 above. This Chapter provides additional, townscape specific information to be used in steps 2 to 5 of the guidance given in Chapter 5 (there is no townscape specific information for step 1). It refers to the Townscape Appraisal Worksheet, which should be completed unless townscape impacts have been scoped out in step 1.

7.2.2 For each key environmental resource (townscape character area – see below), the Townscape Appraisal Worksheet identifies the features Layout, Density and mix, Scale, Appearance, Human interaction, Cultural and Land use, each of which is described and assessed against the following indicators: Scale it Matters, Rarity, Importance, Substitutability and Baseline changes. The impact is recorded in the seventh column. The assessment score is derived from Table 4 which gives a seven point scale based on the proposal's fit with the features of the townscape, visual impact, loss of character, degree of mitigation and effect on policies.

7.2.3 **Step 2** identifying key townscape environmental resources and describing their features, starts by describing the urban character. This process is a means of systematically recording and expressing the characteristic and locally distinctive features of an area. Use can be made of documents which describe an area, such as townscape appraisals, Conservation Area character appraisals, descriptions of listed buildings and Local Plan policies. This will provide the baseline character against which the incremental impact of proposals on that character can be appraised.

7.2.4 Given that 'townscape' is a complex mix of physical features and patterns, and cultural understandings, the level of detail to which townscape character assessment and appraisal is undertaken depends very much on the purpose of the exercise and the type of townscape in question. Key townscape environmental resources should be identified, bearing in mind the need for coherence of character within each resource and distinctiveness of character between resources.

7.2.5 In order to accurately assess the character of a key townscape environmental resource, it is necessary to identify and describe the features of the townscape in the first column (headed **Description)** in the Townscape Appraisal Worksheet. **Features** are the summation of those attributes which most strongly define a key townscape environmental resource and which exhibit the impacts of a scheme. They are a mixture of physical (development form) and cultural characteristics and the way in which people perceive these characteristics. Definitions of the features which combine to define townscape are given below.

- **Layout** is the way that buildings, routes and open spaces are placed in relation to each other. It provides the (usually) two dimensional arrangement on which all other aspects of the form and uses of a townscape depend. Note that, in some locations, if the underlying topography is hilly, layout must be considered in three dimensions, It is influenced by the structure of the

townscape (the connecting framework and hierarchy of routes and spaces) and by the urban grain. This is the pattern of the arrangement and area of buildings and their plots in a settlement and the degree to which an area's pattern of streets and junctions are small and frequent (fine grain) or large and infrequent (coarse grain). For example: "this townscape is characterised by residential streets interspersed with small urban parks".

- **Density and mix** refers to the amount of floorspace of buildings relative to an area and the range of uses. Density determines the intensity of development and with mix contributes to the vitality and viability of a townscape. For example, a transport scheme may encourage the preponderance of certain building uses within an area.
- **Scale** is the size of buildings and structures in the townscape in relation to their surroundings. It can be understood in terms of the height and mass of buildings and structures. Height determines the relationship between buildings, structures and spaces and the visual impact on views, vistas and skylines. Note that the impact of height can be more complex where the underlying topography is hilly. For example, the construction of a road flyover or rail viaduct may have a major impact upon the sense of enclosure, and on views and vistas and skylines.
- **Appearance** and local distinctiveness of buildings and structures within a townscape are influenced by their detail and materials. Detail refers to the craftsmanship, building techniques, facade treatment, styles and lighting. Materials refers to the texture, colour, pattern and durability and how they are used. It is important to appraise how well, or poorly, transport plans fit in with the appearance of buildings and structures.
- **Human interaction** - this term relates to the way people - rather than vehicles - interact with the urban environment. A major element in this relationship is how the community works in terms of interactions in those places that together contribute to townscape. It is important to appraise how social interactions and their relationship with townscape may be changed by the implementation of a transport scheme. In an urban environment communities are omnipresent. However the centres of those communities (e.g. main shopping areas) may be more highly valued. One indicator of whether a strong community exists will often be the presence and scale of pedestrian activity (particularly in the centres of communities), together with the quality of the pedestrian environment (excluding any noise or air quality factors, covered elsewhere). One can imagine an environment where, for example, high levels of pedestrian activity on narrow pavements are in close proximity to heavy vehicle flows. This attribute should also take account of more static interactions between townscape and people, such as the presence of shops, pavement cafes, and seating.
- **Cultural** - this term should cover descriptions of how townscape elements of a traditional or historic nature contribute to townscape character. For example, built forms and architectural styles, the presence of coherent groups of buildings or distinctive street patterns, and notable and cherished buildings and other cherished features. Description of such townscape features must be viewed in terms of their contribution to the overall townscape character, rather than in terms of their historic environment value, which will be separately appraised in more detail under the Historic Environment topic.
- **Summary of character** - this should summarise and pull together the relationship between the primary characteristics and features or attributes of the key townscape environmental resource being appraised. More general

observations on the texture and diversity of the townscape, its scenic qualities, type and degree of development and visual unity or disharmony should be made here.

7.2.6 **Step 3**, the appraisal of townscape environmental capital, appraises what matters in the townscape and why it is important. This provides a base level of environmental capital against which the impact of the proposal on that level of capital can be appraised. Townscape indicator columns in the Townscape Appraisal Worksheet are defined below.

- **Geographical scale** - This is about the geographical scale at which the feature matters to both policy makers at all levels and to the local stakeholders (businesses, interest groups, residents, and so on). The scale at which features matter will not necessarily be on the same scale as the feature itself. For example, a large urban park may only matter to local people, while conversely a small single element in the townscape, for example, the Sainsbury Wing of the National Gallery, will matter at a national scale for a number of reasons.
- **Rarity** - should be interpreted as to whether the townscape features being evaluated prior to impact appraisal are commonplace to the locality or scarce. Rarity often relates directly to importance. For example, the inter-relationship between buildings and open spaces may be a commonplace feature of the local townscape at the scheme level, but it has high importance and matters at a national scale. Conversely, the use of certain building materials or architectural styles could make an important contribution to townscape character locally, and thus be relatively rare within the townscape at the scheme level, but will be of less than regional importance. Retention of townscape character is as much about safeguarding and keeping the commonplace common as conserving and protecting the rare.
- **Importance** - meaning how important is this feature; at what level is it important, for example, high, medium, or low and at national/regional/local level; and to whom is it important. For example, an individual building or group of buildings e.g. local authority offices, may be of very high importance at the local level, both in symbolic significance and as a townscape element framing views of the skyline, but do not figure at a regional or national level. In answering this question, qualitative judgments must be made, but not just about townscape quality in isolation. Assessing importance is straightforward where recognised policy judgments about the importance of features (and their associated elements) have been made, for example, through the planning process. Designated structures and areas, such as listed buildings, registered parks and gardens and conservation areas will guide assessments of importance, but do not provide a simple definition of importance. For example, Conservation Areas should not be seen as of only local importance, as local authorities are responsible for making these designations. However it must be recognised that the majority of the urban environment comprises undesignated townscapes, which can also be of high quality and of great importance. This will, out of necessity, be both a matter for professional judgment (for example quality, survival, diversity) and public perception (for example, local views and walks with cultural connotations and associations). The subjectivity of assessing importance is an integral part of townscape appraisal and should not be regarded as a weakness of it. This approach also enables policies with environmental objectives based on quality to be set within the context of character assessment and appraisal.

- **Substitutability** - This column identifies whether townscape features and their constituent elements are substitutable or not within a given time frame. A key difference between landscape and townscape appraisal in terms of Substitutability is that most townscape functions can be replaced to some extent, which is often not the case for landscape.
- **Baseline Changes** (or, changes in the "without scheme" case) - Change is a constant feature of the urban environment and reflects the dynamic nature of humans and their activities. The characteristics of the urban environment and our perceptions of them are constantly changing. Physical and social characteristics change as buildings, structures, routes and squares are added, removed, modified or their use altered. People's perceptions also change as, over time, their values change. In addition, as people move in and away from an urban area, society's collective perceptions about the urban environment will alter. Change in the urban environment may arise as a result of specific projects (e.g. a new building), changes in transport and non-transport policies (e.g. the introduction of traffic calming measures, or new housing policies) or as a result of other influences (e.g. changes in cultural preferences). Due to its changing nature, the urban environment has great potential to be enhanced by change. Equally, the potential for an urban area to change for the better, either through positive intervention or in a more evolutionary manner, can be stymied by unsympathetic proposals. It is therefore important that impacts are appraised with a good understanding of the dynamics of an urban area, including its potential. These changes, which will or could occur in the absence of specific transport schemes - the 'without scheme case - need to be taken into account in appraising specific transport schemes. This column in the worksheet should be used to identify the key changes that will occur in the absence of the transport scheme.

7.2.7 **Step 4,** appraising the scheme's impact on townscape, should be summarised in the column headed **Impact.** This column should be used to systematically **describe** and **score** the potential impacts of the scheme on the townscape features. These should have been succinctly described and categorised against the indicators set out above. In assessing impact, the information on **Importance** and **Substitutability** will be particularly relevant. All impacts on the townscape, both adverse (damaging) and beneficial (enhancing) must be identified along with their predicted magnitude. In making these assessments, account will need to be taken of baseline changes. The significance of each separate impact can then be appraised and scored. Any uncertainties over any of these aspects should be explained. The views of all the relevant authorities, statutory bodies, organisations and local residents should be brought to bear in making a decision as to the extent and significance of the impacts on the character and quality of each townscape feature and its constituent elements. This will be easier where an environmental impact assessment has been carried out. Where such information does not exist it should still be possible, however, to make a preliminary judgement of impacts. It will be critical to the appraisal process to address how the scheme could impact on and change:

- the character of key townscape environmental resources, such as effects on the locally distinctive pattern of townscape features;
- the ambience of an urban area and the way people interact with the key townscape environmental resource; and

- the tolerance of the key townscape environmental resource to accommodate further change.

7.2.8 It is accepted that any scheme will include appropriate environmental design measures as part of its design to achieve best fit within the townscape. The impact of each scheme on the townscape should be judged on this basis.

7.2.9 It may also be appropriate to consider whether further, additional mitigation measures should be considered over and above that included in the design of the scheme. This will enable new ideas for mitigation not expressed in environmental assessments to be considered to determine whether all mitigation measures proposed will be:

- beneficial and cause the scheme to enrich and enhance the character of the townscape, or;
- essential to neutralise the impact of the scheme on the character of the townscape, or
- ineffective in reducing/minimising the impact of the scheme.

7.2.10 Where additional mitigation is considered, it should not be considered in determining the overall assessment score, as no commitment can be made to its implementation. However, its effect on the impacts of the scheme should be noted in the qualitative statement part of the worksheet.

7.2.11 In **step 5**, determining the overall assessment score for townscape, it will be necessary to evaluate the significance of each of the individual impact scores for each townscape feature. An important pointer will be the impact score for "summary of townscape character" as this should best indicate how well the proposal would fit with the townscape. However, even when a scheme would fit well with urban environment, there may be an impact on particular townscape features that could dominate the initial fit. For example, a well-designed scheme that includes environmental design measures could nevertheless, because of the chosen alignment, bisect and fragment the form and social character of an important and nationally significant key townscape environmental resource.

7.2.12 The overall impact on the townscape is summarised using the Appraisal Summary Table's standard seven point scale (Slight, Moderate or Large Beneficial or Adverse, plus Neutral) See Table 4 for guidance on allocating an assessment score on the seven-point scale.

7.2.13 Where more than one key townscape environmental resource (character area) has been identified, the guidelines for step 5 given in chapter 5 should be used to derive an overall assessment score to be reported in the Appraisal Summary Table.

Table 4 Townscape- Definitions of Overall Assessment Scores

Score	Comment
Large beneficial (positive) effect	The scheme provides an opportunity to enhance the townscape because: • it enhances the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape; • it enables the restoration of the characteristic features of the townscape, partially lost or diminished as the result of changes resulting from inappropriate development • it enables a sense of place and scale to be restored through well-designed mitigation measures, that is, characteristic features are enhanced through the use of local materials to fit the proposal into the townscape • it enhances the character of the townscape through beneficial and sensitive design in a townscape which is not of any formally recognised quality • it facilitates government objectives to regenerate degraded urban areas
Moderate beneficial (positive) effect	The scheme provides an opportunity to enhance the townscape because: • it fits very well with the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape; • there is potential, through environmental design measures, to enable the restoration of characteristic features, partially lost or diminished as the result of changes resulting from inappropriate development • it will enable a sense of place and scale to be restored through well-designed environmental design measures, that is, characteristic features are enhanced through the use of local materials to fit the proposal into the townscape • it enables some sense of quality to be restored or enhanced through beneficial and sensitive design in a townscape which is not of any formally recognised quality • it furthers government objectives to regenerate degraded urban areas
Slight beneficial (positive) effect	The scheme: • fits well with the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape; • incorporates environmental design measures for mitigation to ensure they will blend in well with surrounding townscape. • will enable some sense of place and scale to be restored through well-designed environmental design measures. • maintains or enhances existing townscape character in an area which is not designated for the quality of its townscape, nor vulnerable to change. • avoids conflict with government policy of enhancing urban environments
Neutral effect	The scheme are well designed to: • complement the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape;

Score	Comment
	• incorporate environmental design measures to ensure that the scheme will blend in well with surrounding townscape characteristics and elements • avoids being visually intrusive nor have an adverse effect on the current level of tranquillity (where these exist) of the townscape through which the scheme passes. • maintains existing townscape character in an area which is not a designated townscape, that is, neither national or local high quality, nor is it vulnerable to change. • avoids conflict with government policy towards enhancing urban environments
Slight adverse (negative) effect	The scheme: • does not quite fit the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape • although not very visually intrusive, will impact on certain views into and across the area. • cannot be completely integrated because of the nature of the scheme itself or the character of the townscape through which it passes. • affects an area of recognised townscape quality. • conflicts with local authority policies for enhancing urban environments
Moderate adverse (negative) effect	The scheme is: • out of scale or at odds with the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape • is visually intrusive and will adversely impact on the townscape • not possible to fully integrate, that is, environmental design measures will not prevent the scheme from scarring the townscape in the longer term, as some features of interest will be partly destroyed or their setting reduced or removed. • will have an adverse impact on a townscape of recognised quality or on vulnerable and important characteristics or elements. • in conflict with local and national policies to enhance the urban environment
Large adverse (negative) effect	The scheme is very damaging to the townscape in that it: • is at considerable variance with the layout, mix, scale, appearance, human interaction and cultural aspects of the townscape. • is visually intrusive and would disrupt fine and valued views of the area. • is likely to degrade, diminish or even destroy the integrity of a range of characteristic features and elements and their setting. • will be substantially damaging to a high quality or highly vulnerable townscape, causing it to change and be considerably diminished in quality. • cannot be adequately integrated • is in serious conflict with government policy for the enhancement of the urban environment

8. Impacts on the Historic Environment

8.1 Introduction

8.1.1 The man-made historic environment ('heritage', or heritage resource, heritage assets) comprises:

- buildings (individually or in association) of architectural or historic significance;
- areas, such as parks, gardens, other designed landscapes or public spaces, remnant historic landscapes and archaeological complexes; and
- sites (e.g. ancient monuments, places with historical associations such as battlefields, preserved evidence of human effects on the landscape, archaeological sites and so on).

The historic environment also includes the sense of identity and place which the combination of these features provides.

8.1.2 The characteristics of the historic environment may be commonplace and contribute to local identity, being representative of the distinctiveness of an area. They may also be significant due to their rarity, exemplary form or style, or historical associations. Appreciation of characteristics can change with time (e.g. recent listing of post-war buildings), and trends in character and identity of the historic environment should be taken into account during its appraisal.

8.2 Methodology

8.2.1 The methodology for appraising the impact of schemes on the historic environment follows the five step general approach to appraising 'environmental capital' described in Chapter 5 above. This Chapter provides additional, historic environment specific information to be used in step 2 to 5 of the guidance given in Chapter 5. It refers to the **Historic Environment Appraisal Worksheet**, which should be completed unless historic environment impacts have been scoped out in step 1.

8.2.2 A similar approach to the analysis of impacts on the historic environment is adopted in the Highways Agency's Design Manual for Roads and Bridges, DMRB LA 106, Cultural Heritage Assessment. While DMRB LA 106 is designed for use on major highway projects, it is likely to be useful for the appraisal of other modes, too.

8.2.3 **Step 2** identifying key historic environmental resources and describing their features, involves describing the character of the historic environment in question. Key historic environmental resources should be identified. Note that key historic environmental resources should not automatically be equated with individual heritage assets. Wherever possible, key historic environmental

resources should represent groups of heritage assets, bearing in mind the need for coherence of character within each resource and distinctiveness of character between resources.

8.2.4 For each key environmental resource, character is described using a series of **Features**, against each of which brief descriptive text characterises the resource. Features are the attributes which most strongly define the key historic environmental resource. The Features are listed on the left of the Historic Environment Appraisal Worksheet, and the Description column provides the space to describe the resource in appropriate terms. These features are designed to be applicable to the historic built environment as well as archaeological sites and monuments. There is likely to be reasonable consistency through use of standard descriptive approaches, such as Scheduled Monument classifications, Listed Building descriptions, Conservation Area character appraisals and other sources. This should make appraisal of specific schemes, and comparisons between them, as straightforward and consistent as possible. This descriptive process does not involve qualitative judgements; the significance of the characteristics described forms the subsequent step. The definition of each feature is given below.

Form - This is the physical form of the site, building(s), historic land/townscapes or other heritage assets being described and appraised. It should consist of a factual description setting out their structure, scale, extent, materials, style and format. It should focus on the characteristic features of the historic environment in question. It might usefully be phrased in hierarchical terms, starting with main structures/features, and moving on to their scale, extent, construction and materials. (e.g. Farm, main house and outbuildings, house in brick, 2 storey, slate roof, cobbled yard surfaces, brick and timber barn, enclosed by moat, wet, on 3 sides, north arm infilled). This is not restricted to a site by site description of individual buildings or other components, but can also encompass area descriptions such as the form, scale, layout and pattern of a historic landscape or townscape.

- Table 5, below, presents a set of illustrative terminologies that can be used to identify historic environment form.

Table 5 Historic Environment - Form Terminology (Illustrative, not comprehensive)

Building (inhabited - roofed)
Building (uninhabited - would generally be roofed)
Ruined Building (generally once roofed)
Standing Structure (bonded, such as a free-standing wall)
Ruined standing structure
Standing Structure (unbonded, such as drystone work)
Earthwork (positive upstanding feature, including those with substantial stone component such as hedge banks)
Negative earthwork (ditch)
Accumulated deposits (urban archaeological deposits of stratified material)
Flat/non-accumulated deposits (cropmarks, soilmarks and so on)
Conservation Area
Park or Garden (registered)
Battlefield
Historic urban core zone
Historic building complex (e.g. terrace, house with outbuildings)

- **Survival** - The historic environment survives in many different states of completeness. The area of a monument or landscape may have been reduced by some forms of land use, such as ploughing or quarrying, or elements of a building or area lost through occasional or progressive alteration so that original or important fabric has been removed or damaged. Many parts of the historic environment, especially buildings and urban areas, are products of multiple phases of development and use. Judgement must be applied to determine which are the most characteristic elements in question, and it is their survival which should be indicated here. The relationship between multiple characteristics is covered below under complexity. A text description of the extent of survival of the likely original or characteristic element should be given, along with a more general estimate based on a 3 point scale: Poor, where less than 40% remains; Moderate, where 40-70% remains; Good, where over 70% remains intact. Note that survival may be unknown for some key historic environmental resources (for example, an archaeological site may have been identified by aerial photography but not examined any further).
- **Condition** - This represents the appearance and present management of the key historic environmental resource, along with its stability and likely rate of change from existing condition. It is quite distinct from survival, in that a roofless ruin might be very incomplete as a result of historic damage or decay but currently be very well managed and maintained as a historic monument, and therefore what remains would be in good condition. This description should refer to any erosion or other factors which might cause decay, any current management and maintenance regimes and any problems with them, and any inherent instabilities.
- **Complexity** - This represents both the diversity of elements and their relationships within a part of the key historic environmental resource and the

wider complexity of its relationships beyond its immediate limits. Within a location, this could include a complex sequence of additions to a building over a lengthy period of development, such that it is composed of and representational of a multi-period and stylistically diverse development. These could be of historical or architectural significance. Alternatively, an individual structure might be relatively uncomplicated in period and style, but represent one type among a wide variety within a class of sites and be illustrative of that diversity. Beyond a single location, this could include the relationships among a group of sites or structures in an area, either where the sites (structures) are related (in form, scale, pattern, date or use) as a group, or contribute to a wider historic landscape or townscape which is significant through its diversity of elements illustrative of its historic development. Note that these considerations apply to archaeological sites as well as to buildings.

- **Context** - This represents the immediate setting of a site, building or area, and its intelligibility within its surroundings. It covers the quality and detail of its immediate visual context, and the value of any associations within that context with other elements either of related period and class or as part of the continuing evolving development of its setting. The quality of the setting should be described, along with the intelligibility of the heritage assets and the integrity of their multiple elements (where appropriate) in that setting. This should include the more intangible characteristics, such as tranquillity and other attributes which give a sense of place to the historic environment and help to determine appreciation of it. It should be borne in mind that not all elements of the historic environment are aesthetically pleasing; these can still be important characteristics and contribute to appreciation and understanding of the resource.
- **Period** - This should be a representation of the date of origin and duration of use of the key historic environmental resource described. For some archaeological sites, a period description will be based on the illustrative list given in Table 6 (Medieval, for example); for some buildings this will also be the case. However, many archaeological sites and most buildings and other types of structure will be capable of description in more specific and useful terms, which should be used to provide as clear a description of the feature as possible (such as Victorian, C19, 1865 or Hadrianic, second century). It would also be appropriate to include special historic or architectural associations and interest which contribute to the character of the heritage assets, such as the architect responsible, historic events taking place or notable figures linked to the place.

Table 6 Historic Environment - Period Terminology (mainly archaeological sites; not comprehensive for later or more specific dates)

Lower Palaeolithic	(pre 30,000 BC)
Upper Palaeolithic	(30,000 - 10,000BC)
Mesolithic	(10,000 - 3,500BC)
Neolithic	(3,500 - 2,000BC)
Bronze Age	(2,000 - 700BC)
Iron Age	(700BC - AD43)
Roman	(AD43 - AD450)

Early Medieval	(AD450 - AD1066)
Medieval	(AD1066 – AD1540)
Post Medieval	(AD1540 onwards)

8.2.5 **Step 3** the appraisal of historic environmental capital, involves appraisal against a set of judgemental **indicators** to establish the significance of each key historic environmental resource in question. These indicators should be applied to all of the features described under step 2 of the process above. These are an attempt to move away from a simple designation led approach, since the varying sets of legislation and levels of designation for the historic environment do not lend themselves readily to such a hierarchical system. Rather than apply notional absolute values to qualities of the historic environment, this step seeks to establish the significance of features within their context and work towards relative values. For example, medieval moated sites are quite common in low-lying parts of southern England, and are nationally well-represented in the archaeological resource. They are rare in upland areas, especially in the north, and so a typical example (in terms of its form) in Cumbria would be potentially much more significant in its region and nationally than an equivalent site in the south of the country. This appraisal of the significance of the key historic environmental resources is represented on the Historic Environment Appraisal Worksheet by the three indicators listed below.

- The **Scale it Matters** is about the geographical scale at which the features matter to both policy makers at all levels and to local stakeholders (residents, interest groups, businesses, etc.). Do they contribute to fulfilment of policy commitments at a national level (e.g. government obligations under the UNESCO World Heritage Convention; heritage policies in the National Planning Policy Framework (CLG, 2012)), or regional or local objectives (such as those set out in Local Plans)? Some regional and local objectives might also represent national policy aims, simply expressing local contributions to larger targets. Where this is the case the higher policy levels addressed should be flagged up in the Worksheet. The scale at which characteristics, described against each feature, matter will not necessarily be on the same scale as the attribute itself. An extensive historic land/townscape, such as parks and gardens, or Conservation Areas, may primarily matter to local communities and users, while another similar (in geographic extent) area may relate to events of national significance, such as historic battlefields (e.g. Hastings).
- **Significance** is the value of a heritage asset to this and future generations because of its heritage interest. That interest may be archaeological, architectural, artistic or historic. Significance derives not only from a heritage asset's physical presence, but also from its setting. The **Significance** column should contain information on designations, which are indicative of significance. However, significance is not wholly based on designations, statutory or otherwise, and additional information should be incorporated to appraise significance within its context. This should allow for a greater degree of differentiation between individual features, which might all have the same level of designation or none, but which are not all of equal significance within their context. It may also allow for discrimination within designated areas, since not all parts of an area are necessarily of equal significance.

Non-designated elements of the historic environment may also be of great significance, either through recognition in other, non-designation formats or as major contributors within a locality to identity or character. They may simply not be designated, but be of equivalent importance to those which are, as a result of the technicalities of legislative frameworks. The great majority of buildings and structures, areas, and monuments in the country will remain undesignated and have no statutory protection; they may still be significant, and this will be a matter for professional judgement based on available data, or dependent on the perceptions of other stakeholders. It is important to identify characteristics which are of special significance at local, regional or national scale. Although, under Scale it Matters, some features may be most important at a local level (and not matter significantly at regional or national level) they could be among the most valuable and characteristic elements within a local context and have particular value to local stakeholders. This will be an important factor in determining the level of impact in the subsequent sections. (This also applies at regional and national levels).

- The **Rarity** column should contain information on the historic environment and its features in terms of its representational value (some features are very rare either nationally or within their locality, others are relatively common and typical and so important characteristics of a period or region, etc.), the diversity of the class into which it falls (some classes are represented by numerous regional or typologically distinct types, others are relatively simple and exhibit little variation), and potential (some heritage assets provide opportunities for research, understanding, interpretation and presentation which may not be available at other examples due to prevailing circumstances). The fragility and vulnerability of the historic environment should also be considered, since while there may be numerous surviving examples of a site or attribute they might all be so fragile or under such threat that widespread losses could entirely change the level of survival of the whole class (e.g. non-designated urban features subject to development pressures; coastal archaeology threatened by patterns of erosion). It has to be borne in mind that the historic environment is not a replaceable or substitutable resource.

8.2.6 **Step 4** involves describing the impact of the scheme. The **Impact** column should contain an assessment of the impact of the scheme on the significance of the features identified and described in steps 2 and 3 of the framework for each key environmental resource. It should provide an assessment of the scale and seriousness of the impact in specific terms. This should encompass incremental or secondary impacts, such as gradual degradation of context through noise or other pollution, and so on. The extent to which the identified significance will be either compromised or enhanced should be made clear, including the mitigating effects of any amelioration incorporated formally into the scheme or allowed for as standard good practice. All impacts on the key historic environmental resources, either adverse or beneficial, should be identified, along with their magnitude. The time period for consideration of impacts should include the worst-case case, whenever this would arise, and the situation in the final forecast year.

Overall Assessment Score

8.2.7 **Step 5**, determining the overall assessment score, builds on all the information recorded in the Historic Environment Appraisal Worksheet, using the definitions for overall impact scoring shown in Table 7. The definitions shown in Table 7 are based on the seven point scale for scoring of impact. In addition, a means of identifying exceptionally severe adverse impacts is provided for by the rating 'Very Large Adverse'. Note that any use of the term 'Site' is as a shorthand for monuments, buildings, areas, land/townscapes and so on; it is not restricted to statutory designated or spatially restricted locations, or archaeological features.

8.2.8 Following the appraisal methodology set out above, and summarised in the Historic Environment Appraisal Worksheet, each key historic environmental resource should be given an assessment score, based on the definitions shown in Table 7. Where more than one key historic environmental resource has been identified, the guidelines for step 5 given in Chapter 5 should be used to derive an overall assessment score to be reported in the Appraisal Summary Table. At Stage 2 in the Transport Appraisal Process, good design should already have removed or mitigated the worst avoidable impacts, and so those which remain in the Large (or Very Large) category should have this clearly set out in the final assessment score for appraisals at this Stage.

Table 7 Historic Environment - Definitions of Assessment Scores

Score	Comment
Large beneficial (positive) effect	The scheme would: • provide potential, through removal, relocation or substantial mitigation of very damaging or discordant existing impacts (direct or indirect) on the historic environment, for very significant or extensive restoration or enhancement of characteristic features or their setting • make a major contribution to government policies for the protection or enhancement of the historic environment • remove or successfully mitigate existing visual intrusion, such that the integrity, understanding and sense of place of a highly valued area, a group of sites or features of national or regional significance is re-established
Moderate beneficial (positive) effect	The scheme would: • provide potential, through removal, relocation or mitigation of damaging or discordant existing impacts on the historic environment, for significant restoration of characteristic features or their setting • contribute to Regional or Local policies for the protection or enhancement of the historic environment • enhance existing historic landscape/townscape character through beneficial landscaping/mitigation and good design
Slight beneficial (positive) effect	The scheme : • is not in conflict with national, regional or local policies for the protection of the historic environment. • restores or enhances the form, scale, pattern or sense of place of the historic environmental resource through good design and mitigation • removes or mitigates visual intrusion (or other indirect impacts) into the context of locally or regionally significant historic environmental features, such that appreciation and understanding of them is improved
Neutral effect	The scheme: • is not in conflict with, and does not contribute to policies for the protection or enhancement of the historic environment • maintains existing historic character in a landscape/townscape • has no appreciable impacts, either positive or negative, on any known or potential historic environmental assets • is a combination of slight positive and negative impacts, on locally significant aspects of the historic environment • does not result in severance or loss of integrity, context or understanding within a historic landscape
Slight adverse (negative) effect	The scheme would: • be in conflict with local policies for the protection of the local character of the historic environment

Score	Comment
	• have a detrimental impact on the context of regionally or locally significant assets, such that their integrity is compromised and appreciation and understanding of them is diminished • damage locally significant historic environmental features for which adequate mitigation can be specified • not fit well with the form, scale, pattern and character of a historic landscape/townscape/area
Moderate adverse (negative) effect	The scheme would: • be out of scale with, or at odds with the scale, pattern or form of the historic environmental resource • be intrusive in the setting (context), and will adversely affect the appreciation and understanding of the characteristic historic environmental resource • be in conflict with local or regional policies for the protection of the historic environment • be damaging to nationally significant historic environmental assets, resulting in loss of features such that their integrity is compromised, but not destroyed, and adequate mitigation has been specified • be a major direct impact on regionally or locally significant historic environment, resulting in loss of features such that their integrity is substantially compromised, but adequate mitigation can be specified
Large adverse (negative) effect	The scheme would: • have a major direct impact on nationally significant historic environmental assets such that they are lost or their integrity is severely damaged • have a moderate direct impact on or compromise the wider setting of multiple nationally or regionally significant historic environmental assets, such that the cumulative impact would seriously compromise the integrity of a related group or historic landscape/townscape • have a major direct impact on regional historic environmental assets, such that their integrity is lost and no adequate mitigation can be specified • be highly intrusive and would seriously damage the setting of the historic environment, such that its context is seriously compromised and can no longer be appreciated or understood • be in serious conflict with government policy for the protection of the historic environment, as set out in PPG 15 and PPG 16 • be strongly at variance with the form, scale and pattern of a historic landscape/townscape

9. Impacts on Biodiversity

9.1 Introduction

9.1.1 The guidance in this Chapter is based on advice from Natural England. Its purpose is to advise on how to appraise the costs and benefits of transport schemes in terms of their effects on both biodiversity and earth heritage (geological) interests.

9.1.2 For road-based schemes, guidance on the assessment of biodiversity and earth heritage is provided in DMRB LA 108. For other modes, the guidance in DMRB may provide a useful starting point. 'Guidelines for Ecological Impact Assessment in the UK' (CIEEM,2006), developed by the Chartered Institute of Ecology and Environmental Management to promote good practice in Ecological Impact Assessment in the UK, may provide valuable background information.

9.2 Methodology

9.2.1 The methodology for appraising the impact of proposals on biodiversity follows the five step general approach to appraising 'environmental capital' described in Chapter 5 above. This Chapter provides additional, biodiversity specific information to be used in steps 2 to 5 of the guidance given in Chapter 5. It refers to the **Biodiversity Appraisal Worksheet**, which should be completed unless biodiversity impacts have been scoped out in Step 1.

9.2.2 **Step 2**, identifying key biodiversity environmental resources and describing their features, identifies and describes what biodiversity currently exists and any discernible trends which would lead to degradation or loss of those characteristic features in the absence of the proposals. In line with the environmental assessment, only those key environmental resources where the project has the potential for significant effect should be included.

9.2.3 Character is described using two **Features**, against each of which brief descriptive text characterises the key biodiversity environmental resource. This descriptive process does not involve qualitative judgements; the significance of the characteristics described forms the subsequent step. The definition of each feature is given below.

- **Area** - All key biodiversity and earth heritage environmental resources affected, or potentially affected, by each option should be listed in the Biodiversity Appraisal Worksheet. It is important that a broad approach is taken which covers all relevant resources, including both designated and non-designated sites and protected species. In determining this list, reference to Natural England's Natural Area profiles is recommended in order that the appraisal can be set in the context of the biodiversity and earth

heritage objectives of the area as a whole. Local Biodiversity Action Plans should also be taken into account. Thus the 'area' listed could relate to a specific site, or to a more general area relating to a habitat of importance in the context of the Natural Area's objectives.

- **Feature** - Strictly speaking, the Environmental Capital approach suggests that all the different features of a key environmental resource should be appraised separately. Thus, for example, a Site of Special Scientific Interest (SSSI) may have two main features: biodiversity and recreation. In such cases the features should be listed and evaluated separately. However, it may be difficult in practice to disaggregate the individual features of a biodiversity and/or earth heritage key environmental resource. An alternative is to describe the feature of interest. Features of the site should be described at Phase One habitat type or species group level (for example birds, wetland invertebrates, dry heath etc). A key environmental resource may have more than one feature. Where different features lead to different assessment scores, they should be entered on different lines on the Worksheet and appraised separately. Where this is not the case, it is sufficient to group and describe the features on a single line, bearing in mind the need for coherence of character within each resource and distinctiveness of character between resources.

9.2.4 **Step 3** involves appraising the environmental capital for each feature against a set of judgemental **Indicators** to establish the significance of the key biodiversity environmental resource in question. These indicators should be applied to all of the features described under step 2 of the process above. This appraisal of the significance of the biodiversity resource is represented on the Worksheet by the four indicators listed below.

- **Scale at which the feature matters** - This could be 'international', 'national', 'regional' or 'local'.
- **Importance** - This column allows a descriptive assessment of the biodiversity and earth heritage importance of the feature. For example: "'High' importance - rare granite materials (geological history)". Often the importance of biodiversity and earth heritage features is indicated by a formal designation. In such cases the reasons for its designation should be summarised briefly. Where the feature is not designated, the importance should be considered by judgement in relation to factors such as rarity, representativeness, distinctiveness and quality.
- **Trend** (in relation to a target level) - The abundance of the habitat or natural feature relative to its target level (where appropriate) and its trend, where known (in relation to Biodiversity Action Plan targets, for example).
- **Substitution possibilities** - This aims to take account of the fact that the loss of an irreplaceable natural feature is often considered to be more significant than one that is replaceable. A judgement must, therefore, be made according to whether the habitats / species or natural features are substitutable or not substitutable. The diversity and complexity of habitats can have a significant influence over the extent to which habitats can be replaced. Issues to be considered include: whether the habitat(s) are technically replaceable to a sufficient quality; or whether the species can be successfully relocated; or whether the ecosystem services provided by the feature could be fully substituted. Clearly, these are difficult considerations. Many habitats are not wholly re-creatable. For example, if one loses a 200

year old woodland, even in 200 years' time, its replacement will not be as old (and biologically diverse) as the original habitat would have been. There is also a 'historical continuity' problem and various other problems relating to 'substitution'. A precautionary approach must be taken in this judgement, as research for English Nature has shown (English Nature Science Series No 21, Parker D M. 1995). Where natural habitats remain, these habitats together with those that are classified as semi-natural are likely to be less replaceable than man-made habitats that include areas that have been replanted or recently recreated. Any commitments made in the Environmental Statement or agreed with statutory advisors must be implemented if the proposal proceeds.

9.2.5 Having gathered information against each of the four indicators above, it is then necessary to derive a summary of the biodiversity and earth heritage value of the feature or attribute, based on these four indicators. A guide is set out in Table 8 below.

Table 8 Guidance on Describing the Biodiversity and Earth Heritage Value of Features

Value	Criteria	Examples
Very high	High importance and rarity, international scale and limited potential for substitution	Internationally designated sites
High	High importance and rarity, national scale, or regional scale with limited potential for substitution	Nationally designated sites Regionally important sites with limited potential for substitution
Medium	High or medium importance and rarity, local or regional scale, and limited potential for substitution	Regionally important sites with potential for substitution Locally designated sites
Low	Low or medium importance and rarity, local scale	Undesignated sites of some local biodiversity and earth heritage interest
Negligible	Very low importance and rarity, local scale	Other sites with little or no local biodiversity and earth heritage interest

9.2.6

9.2.7 Table 9 below provides a provisional categorisation based on statutory or local designations, or Biodiversity Action Plan objectives. This can be used as a broad guide for determining biodiversity and earth heritage value, but it is only a starting point. The four indicators described above should be considered in making the overall judgement. For example, it may be considered that a site not designated as an SSSI has high value, since the SSSI series is representative rather than all-inclusive. Conversely, a site hosting a single individual of a widespread Berne Convention species may not warrant the highest classification (as would have been indicated by

9.2.8 Table 9).

9.2.9 Much of the land with Bonn and Berne Convention species interest is covered by designated sites. However, there are cases where important species cannot be covered practically by a site designation, because of their dispersed nature. In some cases, undesignated areas of land hosting Bonn and Berne Convention species will be considered to be of high biodiversity and earth heritage value, for example because of important nesting sites for rare species.

9.2.10 Table 9 suggests that undesignated sites hosting 'significant populations' of Convention species may be considered as of international importance. The judgement about whether the population is 'significant' will vary from case to case. Recording information on this in the footnotes of the Biodiversity Appraisal Worksheet will be helpful.

Table 9 Guide to Biodiversity and Earth Heritage Value

International designations – very high value
Ramsar Sites (Convention on Wetlands of International Importance Especially Waterfowl Habitat 1971)
World Heritage Sites (Convention for the Protection of World Cultural & Natural Heritage, 1972)
Biosphere Reserves (UNESCO Man & The Biosphere Programme)
European Sites (EC Habitats Directive 1992 & UK Habitats Regulations 1994):
Special Areas of Conservation (SACs)
Special Protection Areas (SPAs)
Sites of Community Importance (SCIs)
Possible / Candidate SACs and potential SPAs
Undesignated sites hosting habitats/species of (European) Community interest (annexes 1 & 2, Habitats Directive, 1992)
Undesignated sites hosting significant species populations under the Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals, 1979)
Undesignated sites hosting significant populations under the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats, 1979)
Biogenetic Reserves under the Council of Europe
European Diploma Sites under the Council of Europe
National designations – high value
Sites of Special Scientific Interest (SSSIs; Wildlife & Countryside Act 1981 as amended and National parks and Access to the Countryside Act 1949)
Sites with Limestone Pavement Orders (Wildlife & Countryside Act 1981)
Nature Conservation Review Sites (NCR)
Geological Conservation Review (GCR) sites
Marine Nature Reserves (MNRs; Wildlife & Countryside Act 1981)
Areas of Special Protection for Birds (ASPs; Wildlife & Countryside Act 1981)
Undesignated sites hosting Red Data Book species
Undesignated sites hosting species not covered by the Berne Convention but in schedules 1, 5 and 8 of the Wildlife and Countryside Act 1981
Regionally important and locally designated sites – medium value
Local Nature Reserves (LNRs; National Parks and Access to the Countryside Act 1949)
Sites of Importance to Nature Conservation (SINCs) / County Wildlife Sites (CWSs) / other local designations
Regionally Important Geological Sites (RIGs)
Important ‘inventory’ sites (e.g. ancient semi-natural woodland, and grassland, inventories)
Other undesignated sites (not described above) with Biodiversity Action Plan (BAP) priority habitats/species
Other natural / semi-natural sites of significant biodiversity importance, not referred to above (e.g. sites relevant to local Biodiversity Action Plan / Natural Area objectives)

Other sites with local conservation interest – low value

Sites not in the above categories, but with some biodiversity or earth heritage interest.

Impact Appraisal

9.2.11 **Step 4** involves describing the impact of the scheme. The **Magnitude of Impact** column should contain an assessment of the impact of the scheme on the significance of the features identified and described in steps 2 and 3 of the framework.

9.2.12 It is not realistic to assess the ecological impact based on set rules in terms of the percentage of a site's feature affected. Instead, the impact of a scheme on a site should be considered using the well established ecological concepts of significance and integrity. The extent to which the identified significance will be either compromised or enhanced should be made clear, including the mitigating effects of any amelioration incorporated formally into the proposals or allowed for as standard good practice (mitigation is discussed in more depth below).

9.2.13 The impacts which need to be considered may be direct or indirect, individual or cumulative, temporary or permanent, may be geographically dispersed, and may be harmful or beneficial. Impacts on biodiversity or earth heritage via effects on air, water and soil resources, or via effects from noise, light or water, are also relevant. Note that in this context we are making a judgement about impact purely for the purposes of appraisal i.e. whether the investment of public funds is worth the costs and benefits. The normal planning processes will also continue to apply, for example with respect to European sites.

9.2.14 The basis for the assessment of impact should be the long term condition of the feature under the option being considered, compared with that under a 'without-scheme' case; note that the condition of the latter may be different from its current state. Table 10 below provides guidance on the impact magnitude. Note that the magnitude of the impacts relates only to their physical effects. It is, to an extent, independent of nature conservation value of the feature or attribute affected.

Table 10 Criteria for Determining the Magnitude of the Impact

Magnitude	Criteria
Major negative	The proposal (either on its own or with other proposals) may adversely affect the integrity of the key environmental resource, in terms of the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and / or the population levels of species of interest.
Intermediate negative	The key environmental resource's integrity will not be adversely affected, but the effect on the resource is likely to be significant in terms of its ecological objectives. If, in the light of full information, it cannot be clearly demonstrated that the proposal will not have an adverse effect on integrity, then the impact should be assessed as major negative.
Minor negative	Neither of the above apply, but some minor negative impact is evident. (In the case of Natura 2000 sites a further appropriate assessment may be necessary if detailed plans are not yet available).
Neutral	No observable impact in either direction.
Positive	Impacts which provide a net gain for wildlife overall.

Mitigation

9.2.15 Where schemes include plans for mitigation, this should generally be taken account of in the appraisal of impacts. However, an exception to this general rule is described below. There are three categories to consider:

- design measures to avoid or minimise the impact of the scheme on the key environmental resource(reducing run-off, for example);
- in close proximity to the key environmental resource, mitigation to help conserve existing biodiversity interest where the impacts can not be minimised (e.g. dedicated animal crossings, land management regimes); and
- measures not in close proximity to the key environmental resource (such as habitat replacement) to compensate for biodiversity and earth heritage losses.

These categories should be developed sequentially in scheme design.

9.2.16 The first two categories are essentially about avoiding or minimising the effects on or near the key environmental resource. It is appropriate for these to be considered in appraising impact, provided they have been documented properly. The key is to make an appropriate judgement about net impact. Where there is some risk in the mitigation proposals, it is appropriate to complete separate appraisals, for the 'with' and 'without' mitigation cases.

9.2.17 The third category above is about compensation for expected loss, though in Environmental Statements it is often described as 'mitigation'. A precautionary approach needs to be taken here: often it is not appropriate to lower the impact category on the basis of compensation measures remote from the key environmental resource, as these are unlikely to fully recompense for the lost features. This is especially so for the more valuable key environmental resources.

9.2.18 In later stage appraisals, mitigation measures may be documented in an Environmental Statement. New ideas for mitigation not documented in the Environmental Statement should not be taken account of in the impact appraisal, though they should be suggested in text on the Biodiversity Appraisal Worksheet. Such ideas could then be worked up as a separate scheme, to allow the consequences of adoption to be appraised.

9.2.19 At earlier appraisal stages, Environmental Statements are unlikely to be available. In such circumstances it is reasonable to assume usual mitigation designs for a scheme of this type (such as dedicated animal crossings, for example). Mitigation measures should be considered in the appraisal only where these are feasible and likely to be specified. Evidence from previous schemes of a similar type should be considered. There must be a documented audit trail of mitigation assumptions on which the appraisal is based.

Overall Assessment Score

9.2.20 **Step 5** combines the appraisal of biodiversity and earth heritage value of the features, with the appraisal of the magnitude of the impacts, to determine the consequence of those impacts. The assessment score should be determined using

9.2.21 Table 11 and recorded on the Biodiversity Appraisal Worksheet. Where more than one key environmental resource is involved, an appraisal category is needed for each of these, which are then summarised in an overall summary score on the Appraisal Summary Table for the scheme.

9.2.22 Where a scheme affects more than one key environmental resource, determining the overall summary score is more complex, since the different 'scores' for each key environmental resource considered need to be weighed up in an overall summary score. The guidelines given in Chapter 5 should be followed.

Table 11 Estimating the Overall Assessment Score

Magnitude of impact	**Biodiversity and earth heritage value**				
	Very high	**High**	**Medium**	**Lower**	**Negligible**
Major negative	Very Large adverse	Very Large adverse	Moderate adverse	Slight adverse	Neutral
Intermediate negative	Large adverse	Large adverse	Moderate adverse	Slight adverse	Neutral
Minor negative	Slight adverse	Slight adverse	Slight adverse	Slight adverse	Neutral
Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Positive	Large beneficial	Large beneficial	Moderate beneficial	Slight beneficial	Neutral

(A) Schemes in the ‘very large adverse’ are likely to be unacceptable on nature conservation grounds alone (even with compensation proposals).

(B) There should be a strong presumption against schemes in the ‘large adverse’ category, with more than 1:1 compensation (net gain within the Natural Area) for the very occasional cases where development is allowed as a last resort.

(C) Schemes in the ‘moderate adverse’ category should include at least 1:1 compensation (no net loss within the Natural Area) if the development is allowed.

(D) Positive impacts should be considered to be of lower value if the gains are clearly evident but not significant in terms of the conservation objectives of the Natural Area. Positive impacts should be classed as medium value if they deliver significant gains to the Biodiversity Action Plan objectives in the Natural Area, and as major value if they deliver positive gains of national or international importance.

10. Impacts on the Water Environment

10.1 Introduction

10.1.1 The methodology set out in this Chapter provides an appraisal framework for analysing the key information of relevance to the water environment.

10.1.2 For road-based schemes, guidance on the assessment of impacts on the water environment is provided in DMRB LA 113. For other modes, the guidance in DMRB may provide a useful starting point.

10.2 Methodology

10.2.1 The methodology for appraising the impact of schemes on the water environment follows the five step general approach to appraising 'environmental capital' described in Chapter 5 above. This Chapter provides additional information specific to the water environment[24]. It refers to the **Water Environment Appraisal Worksheet**, which should be completed unless impacts on the water environment have been scoped out in step 1.

10.2.2 Where available, the outputs of an environmental impact assessment process (which may be presented in an Environmental Statement) should be used.

10.2.3 Steps 2 to 4 of the appraisal may have a risk component, where the exact impacts of the scheme are unknown because of uncertainties in exposure and effect. Where uncertainties of this sort are identified, they should be made explicit in the appraisal process. It is recommended that the precautionary principle be employed. Even at larger scales where there is likely to be greater uncertainty regarding the potential impacts, there remains the opportunity to incorporate mitigation measures when the schemes are considered in more detail. In these cases it will be necessary to determine whether the potential risks identified justify invoking the precautionary principle, or whether it will be sufficient to flag them up as issues for more detailed consideration at a later stage.

10.2.4 During **step 1**, scoping, the process will determine information relating to the potential impacts of the scheme and the scale over which they are significant. This enables the size of the study area, and the key water environmental resources in this area that may be affected, to be determined.

10.2.5 The nature of the scheme may vary widely from the introduction of road traffic calming measures to the construction of a new transport route, for example. These measures will obviously have different potential impacts on the water environment. A useful distinction is made between impacts arising from

[24] Note that the terminology of Chapter 5 has been used in this Chapter. This has resulted in changes in the meaning of some words and phrases. In particular, 'water environmental resource' replaces 'feature', 'feature' replaces 'attribute/service' and the term 'attribute' is not used.

construction of new transport infrastructure (e.g. an upgraded rail line, road widening or car parks), and changes in the use pattern of existing infrastructure (such as promotion of cycling or walking, improvements to bus services or traffic flow control technologies). Any transport scheme should fit into one, or both, of these categories.

10.2.6 Once the potential impacts of the scheme have been identified its zone of influence can be determined. For releases to a watercourse, for example, this may be the length of river over which a noticeable change in quality is predicted, while for the creation of new hardstanding, it may represent the area which could be exposed to an increased flood risk.

10.2.7 **Step 2**, identifying key environmental resources and describing the features of each key water environment resource, identifies and characterises those key water environmental resources that may be affected by the proposal. Each key environmental resource is described in Worksheet 1 in terms of **Features**, against each of which brief descriptive text characterises the key water environmental resource. This descriptive process does not involve qualitative judgements at this stage; the significance of the characteristics described is undertaken in step 3. Table 12 provides generic information on the key resources of the water environment and their features that should be used to describe the key environmental resources for a specific study.

10.2.8 For **step 3**, the value of the key water environmental resources within the study area is assessed by analysing their features. This process is consistent with an environmental capital approach because the value of the water environment should be assessed in terms of the services it provides rather than on purely measurable criteria.

10.2.9 The indicators used to make a judgement on the importance of a feature under consideration are listed below.

- **Quality** - this criterion provides a measure of the physical condition of the feature. Table 12 provides guidance on available indicators of quality that can be used for specific features. The Environment Agency maintains data on these quality indicators at a national, or regional, level, usually in digital format.
- **Scale** - It is unlikely that any key water environmental resources will have importance at a national or global scale (assuming that biodiversity interests are appraised separately), however major aquifers, floodplains, or fisheries may be important at a regional scale. It is important to consider the scale at which each feature matters, rather than the resource as a whole, because subsequent appraisals of the rarity, substitutability, and importance will assess the feature at this determined scale. Generally, the greater the scale at which the feature is valued, the greater its importance. However, this will not always be the case. For example, where the resource is of great value to a community for providing a significant proportion of local employment.
- **Rarity** - allows consideration of whether the water attribute being evaluated is commonplace or scarce, at the scale at which it matters. For example an attribute that is abundant nationally (such as potable water) will be of high importance if it is locally rare.

- **Substitutability** - allows consideration of whether water features are replaceable over a given time frame. The significance of the length of time before substitution could be achieved will be linked to the urgency with which the feature is required (a long time frame may be acceptable for inessential features such as recreation, but less so for others, such as supply of potable water). Again the potential for substitution of the feature should be considered in relation to scale at which it matters, but should also consider the risks of failure. Different features of the same key environmental resource may differ in their potential for substitution. Limited potential for substitution recognises that while it is theoretically possible for most water features to be substituted by some means, this will not always be viable within the funds of the scheme. Substitution should therefore be considered in terms of whether it is feasible rather than whether it is possible. Where no information is available relating to the substitutability of the feature, it should be assumed that no substitution is possible.

Table 12 Water Resources, Their Features and Indicators of Quality

Resource	Features	Indicator of quality	Possible measure
River/Canal	Water Supply	• Use for water supply (potable, industrial or agricultural)	• Location and number of abstraction points • Volume of water abstracted • Use of water (potable most important)
		• Chemical water quality	• Existing chemical classification/status and objective under Water Framework Directive (WFD) • Likelihood of a change in classification arising (+ve or –ve)
	Transport and dilution of waste products	• Presence of surface water discharge points	• Location and number of discharge points • Volume of effluent discharged
		• Contribution of discharges to total river flow	• Proportion of flow made up by effluent at different times of the year
	Biodiversity	• Biological water quality	• Existing ecological classification/status and objective under WFD • Likelihood of a change in classification arising (+ve or –ve)
		• Fisheries quality	• EC Fishery designation (Salmonid, Cyprinid or undesignated)
		• Conservation value of river corridor[1]	• Results of River Habitat Survey • Presence of designations (e.g. SSSI, NNR, LNR, SINCs) • Presence of protected species or BAP species
	Aesthetics	• Contribution to landscape character and quality[2]	• Results of river landscape assessment
	Cultural heritage	• Presence of historic features associated with river[3]	• Results of historic environmental assessment • Presence of designations (e.g. SAMs, listed buildings)
	Recreation	• Riverside access	• Presence of route and importance (i.e. is it a nation or strategic route, such as the Thames Path)
		• Use of river for recreation	• Presence of facilities and clubs for using the river environment • Use for angling (number of clubs / membership)

Resource	Features	Indicator of quality	Possible measure
	Value to economy	• Value of the uses of the river (e.g. commercial fishing, abstractions, discharges, navigation, leisure and riverside development land)	• Value to local economy (e.g. employment, relative property prices, cost of alternatives, etc.)
	Conveyance of flow and material	• Presence of watercourses	• Number and size of watercourses • Existing flood risk
Floodplain	Conveyance of flood flows	• Presence of flood zones	• Existing flood risk/flood return period
		• Flood flow routes • Surface water flooding	• Location / importance of flood flow routes • Location of surface water flooding
	Biodiversity	• Conservation value of river corridor[1]	• Results of River Habitat Survey • Presence of designations (e.g. SSSI, NNR, LNR, SINCs) • Presence of protected species or BAP species
	Aesthetics	• Contribution to landscape character and quality[2]	• Results of river landscape assessment
Groundwater	Water supply	• Use for water supply (potable, industrial or agricultural)	• Location and number of abstraction points • Volume of water abstracted • Use of water (potable most important)
		• Groundwater vulnerability	• Location and grade of source protection zone • Classification of aquifer vulnerability • Classification/status and objective under WFD
	Transport and dilution of waste products	• Presence of discharge points	• Location and number of discharge points • Volume of effluent discharged
	Value to economy	• Value of the uses of the groundwater (e.g. abstractions and discharges)	• Value to local economy (e.g. employment, cost of alternatives, etc.)

Resource	Features	Indicator of quality	Possible measure
	Biodiversity	• Conservation value of areas fed by groundwater[1]	• Results of River Habitat Survey • Presence of designations (e.g. SSSI, NNR, LNR, SINCs) • Presence of protected species or BAP species • Presence of Groundwater Dependant Terrestrial Ecosystems under the WFD
	Conveyance of flood flows	• Flow routes	• Location and importance of flow routes
		• Groundwater levels	• Charges in levels and recharge
Sea and Estuaries	Water supply	• Use for water supply	• Location and number of abstraction points • Volume of water abstracted
	Transport and dilution of waste products	• Presence of discharge points	• Location and number of discharge points • Volume of effluent discharged • Classification/status and objective under WFD
	Biodiversity	• Water quality	• Chemical and biological quality (data availability will be variable)
		• Fisheries quality	• Results of surveys etc (numbers / biomass of species and individuals)
		• Invertebrate populations	• Results of surveys etc (numbers / biomass of species and individuals)
		• Conservation value of marine/estuary environment[1]	• Presence of designations (e.g. MNR, SSSI, NNR, LNR, SINCs) • Presence of protected species or BAP species • Presence of Protected Areas under WFD
	Aesthetics	• Contribution to landscape character and quality[2]	• Results of river landscape assessment
	Cultural heritage	• Presence of historic features associated with sea/estuary[3]	• Results of heritage assessment • Presence of designations (e.g. SAMs, listed buildings)

Resource	Features	Indicator of quality	Possible measure
	Recreation	• Designated bathing waters	• Compliance with EC Bathing Water Directive (guideline or mandatory compliance)
		• Other recreation uses	• Presence of facilities and clubs • Use for angling (number of clubs / membership)
	Value to economy	• Value of the uses of the sea/estuary (e.g. commercial fishing, abstractions, discharges, navigation, leisure and waterside development land)	• Value to local economy (e.g. employment, relative property prices, cost of alternatives, etc.)
Stillwaters	Biodiversity	• Water quality	• Classification status and objective under WFD
(Lakes and Ponds)		• Conservation value of stillwaters[1]	• Presence of designations (e.g. SSSI, NNR, LNR, SINCs) • Presence of protected species or BAP species
		• Fisheries quality	• Results of surveys etc (numbers / biomass of species and individuals)
		• Invertebrate populations	• Results of surveys etc (numbers / biomass of species and individuals)
	Aesthetics	• Contribution to landscape character and quality[2]	• Results of river landscape assessment
	Recreation	• Use of still water for recreation	• Presence of facilities and clubs for using lake/pond • Use for angling (number of clubs / membership)

Notes: [1] Include in Biodiversity Impacts, [2] Include in Landscape Impacts, [3] Include in Historic Environment Impacts

10.2.10 Having gathered information against each of the four indicators above, it is then necessary to derive a summary of the **Importance** (or value) for each feature. Table 13 provides guidance for estimating the importance of a feature based on the indicators recorded.

10.2.11 Where all other factors are equal, and explicit, it may be possible to make judgements of value based on the quality indicators provided (e.g. WFD high status is more important than moderate status). However, this level of consistency will rarely be possible, because in the majority of situations the other indicators (scale, rarity and substitutability) will also have important roles in determining importance. For large study areas quality data may be the only indicator available, because the large amount of qualitative data required to assess other indicators may not be practically obtainable.

Table 13 Guidance on Estimating the Importance of Water Environment Features

Value	Criteria	Examples
Very high	feature with a high quality and rarity, regional or national scale and limited potential for substitution	Aquifer providing potable water to a large population (groundwater) Important fish population (surface water) Floodplain or defence protecting more than 100 residential properties (flood risk)
High	feature with a high quality and rarity, local scale and limited potential for substitution feature with a medium quality and rarity, regional or national scale and limited potential for substitution	WFD high status water body (surface water) aquifer providing potable water to a small population (groundwater) Notable fish population (surface water) Floodplain or defence protecting up to 100 residential properties or industrial premises (flood risk)
Medium	feature with a medium quality and rarity, local scale and limited potential for substitution feature with a low quality and rarity, regional or national scale and limited potential for substitution	WFD good status water body (surface water) Aquifer providing abstraction water for agricultural or industrial use (ground water) Floodplain or defence protecting up to 10 industrial premises (flood risk)
Low	feature with a low quality and rarity, local scale and limited potential for substitution	WFD less than good status (surface water) Unproductive strata (ground water) Floodplain with limited existing development (flood risk)

Impact Appraisal

10.2.12 **Step 4** considers the potential impacts of a transport scheme for each water environment feature identified. The potential impacts (both positive and negative) of the scheme should be identified to a level of detail that is appropriate for the stage reached in the study process. Where appropriate, the impacts of a specific scheme will be identified during the environmental impact assessment process and these will then be used in the appraisal.

10.2.13 Their **magnitude** can be determined by appraising the effects predicted for each feature. Table 14 provides guidance on the magnitude criteria for potential impacts, with some examples. The magnitude of the potential impact is completely independent of the value of the feature affected and therefore gives no indication of significance when considered alone. For each feature identified in step 2 and valued in step 3, the magnitude of the impact should be recorded in the magnitude column of the Water Environment Appraisal Worksheet.

10.2.14 Generic to all environmental assessment, uncertainty is an important factor to consider in appraisal. Assumptions should be clearly noted, particularly where a heavy weight on professional judgment is required due to lack of adequate data at the specific scale.

Table 14 Criteria for Determining Impact Magnitude

Magnitude	Criteria	Example
Large Adverse	Results in loss of feature	Loss of important fishery Change in WFD classification of river reach Compromise employment source Loss of flood storage/increased flood risk Pollution of potable source of abstraction
Moderate Adverse	Results in adverse impact on integrity of feature or loss of part of feature	Loss in productivity of a fishery Contribution of a significant proportion of the effluent in the receiving river, but insufficient to change its WFD classification Reduction in the economic value of the feature
Slight Adverse	Results in minor adverse impact on feature	Measurable changes in feature, but of limited size and/or proportion
Negligible	Results in an impact on feature but of insufficient magnitude to affect the use/integrity	Discharges to watercourse but no significant loss in quality, fishery productivity or biodiversity No significant impact on the economic value of the feature No increase in flood risk
Slight Beneficial	Results in minor beneficial impact on feature or a reduced risk of adverse effect occurring	Measurable changes in feature, but of limited size and/or proportion
Moderate Beneficial	Results in moderate improvement of feature	Enhanced productivity of a fishery Reduction in a significant proportion of the effluent in a receiving river, but not sufficient to change its WFD classification Moderate reduction in flood risk
Large Beneficial	Results in major improvement of feature	Removal of major existing polluting discharge to a watercourse Major reduction in flood risk

Overall Assessment Score

10.2.15 **Step 5** combines the appraisal of the importance of the water environment features, with the appraisal of the magnitude of the impacts, to determine the consequence of those impacts. A two step process is required.

The first step is to assess the **significance** of a potential impact on each affected feature.

10.2.16 Table 15 provides guidance for determining the significance of a potential impact based on its magnitude and the importance of the feature, to be input in the Water Environment Appraisal Worksheet.

10.2.17 The second step is to combine the assessment of each feature into an **assessment score** for each key water environmental resource on the eight-point scale. This step should be based on the definitions given in Table 16.

10.2.18 It is not useful to provide wholly prescriptive guidance for determining an assessment score, because each combination of positive and negative impacts will be different. The indicative criteria in Table 16 can be used for guidance, but experience and an understanding of the scheme will also be required. The qualitative comment box on the worksheet should be used to provide further information on the basis for reaching the assessment score for that key environmental resource.

10.2.19 Where a scheme affects a number of key water environmental resources, a judgement will need to be made concerning the overall assessment score for the scheme. The scheme should be classified as a whole and the potential impacts on individual key environmental resources combined in the overall classification, using the guidelines for step 5 given in chapter 5.

Table 15 Criteria for Estimating the Significance of Potential Impacts

	Importance of feature			
Magnitude of potential impact	**Very High**	**High**	**Medium**	**Low**
Major	Very Highly Significant	Highly Significant	Significant	Low Significance
Moderate	Highly Significant	Significant	Low Significance	Insignificant
Minor	Significant	Low Significance	Insignificant	Insignificant
Negligible	Low Significance	Insignificant	Insignificant	Insignificant

Table 16 Water Environment - Definitions of Assessment Scores

Score	Comment
Large Beneficial Impact	It is extremely unlikely that any scheme incorporating the construction of a new transport route (road or rail) would fit into this category. However, a scheme could have a large positive impact if it is predicted that it will result in a 'very' or 'highly' significant improvement to a water feature(s), with insignificant adverse impacts on other water features.
Moderate Beneficial Impact	Where the scheme provides an opportunity to enhance the water environment, because it results in predicted: • significant improvements for at least one water feature, with insignificant adverse impacts on other features; • very or highly significant improvements, but with some adverse impacts of a much lower significance. The predicted improvements achieved by the scheme should greatly outweigh any potential negative impacts.
Slight Beneficial Impact	Where the scheme provides an opportunity to enhance the water environment, because it provides improvements in water features which are of greater significance than the adverse effects.
Neutral	Where the net impact of the scheme is neutral, because: • it has no appreciable effect, either positive or negative, on the identified features; • the scheme would result in a combination of effects, some positive and some negative, which balance to give an overall neutral impact. In most cases these will be slight or moderate positive and negative impacts. It may be possible to balance impacts of greater significance. However, in these cases great care will be required to ensure that the impacts are comparable in terms of their potential environmental impacts and the perception of these impacts.
Slight Adverse Impacts	Where the scheme may result in a degradation of the water environment, because the predicted adverse impacts are of greater significance than the predicted improvements.
Moderate Adverse Impacts	Where the scheme may result in a degradation of the water environment, because it results in predicted: • significant adverse impacts on at least one feature, with insignificant predicted improvements to other features; • very or highly significant adverse impacts, but with some improvements which are of a much lower significance and are insufficient positive impacts to offset the negative impacts of the scheme.
Large Adverse Impact	Where the scheme may result in a degradation of the water environment, because it results in predicted: • highly significant adverse impacts on a water feature; • significant adverse impacts on several water features.
Very Large Adverse Impact	Where the scheme may result in a degradation of the water environment because it results in predicted: • very significant adverse impacts on at least one water feature; • highly significant adverse impacts on several water features.

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Environmental Impact Appraisal

This Chapter is based on the former TAG Unit 3.3.1, which itself was based on Chapter 3, Sections 1 to 3 of Guidance on the Methodology for Multi-Modal Studies Volume 2 (DETR, 2000).

Noise

This Chapter is based on Chapters 4, Section 3 (including worksheets 4.1 and 4.2) of Guidance on the Methodology for Multi-Modal Studies Volume 2 DETR, 2000); together with Section 7.1 of Applying the multi-modal new approach to appraisal to highway schemes ("The Bridging Document") (DETR, 2001). Advice on the monetary valuation of noise impacts was first added in February 2006, and updated to reflect the latest Defra guidance (introduction of values by more for different impact pathways, including sleep disturbance and health impacts) in November 2015.

Air Quality

This Chapter forms guidance on assessing and monetising air quality impacts that was previously in TAG Unit 3.3.3, which became definitive guidance in August 2012.

In May and November 2023, the guidance was updated to reflect new Defra air quality damage cost guidance published in March 2023, which explicitly superseded previous Defra guidance on abatement costs. In May 2023, all references to air quality abatement costs were removed from the Chapter.

Greenhouse Gases

This Chapter is based on Chapter 4, Section 5 (including worksheet 4.5) of Guidance on the Methodology for Multi-Modal Studies Volume 2 (DETR, 2002).

This guidance was updated in September 2006 to include advice on the calculation of monetary valuation for the change in carbon emissiosns.

The guidance was further revised in June 2008 to reflect new Defra advice on the Shadow Price valuation of carbon emissions. This became definitive guidance in April 2009.

January 2010: In Draft Guidance. Latest DECC values for estimated abatement costs of carbon equivalent and guidance for appraising fuel consumption related carbon added to this Unit.

January 2010: Updated In Draft Guidance. Includes DECC-based values for estimated abatement costs of carbon equivalent to 2100, and reference to DECC guidance published January 2010.

April 2011: Updated Guidance. Values in Table 2a for traded carbon between 2010 and 2029 updated in line with DECC values published in June, 2010.

November 2011: Guidance For Consultation, including guidance. Updated with latest DECC values and guidance changed to reflect the reporting of CO_2, rather than Carbon equivalent.

May 2012: In Draft Guidance with some further modifications. This became definitive guidance in August 2012.

Spring 2014: A definitive change was made to the format DECC guidance is cited in this unit. The citation is now shown in a generic format, no longer including the release date.

November 2014: Reference was added to the inclusion in the TAG Data Book of the impact of forecast biofuel uptake on rail diesel fuel consumption rates.

Impacts on Environmental Capital

This TAG Unit replaces previous TAG Unit 3.3.6, which was based on Chapter 4, Section 6 of Guidance on the Methodology for Multi-Modal Studies Volume 2 (DETR, 2000) plus GOMMMS Supplement 1 (DfT, 2002).

Impacts on Landscape

This TAG Unit replaces TAG Unit 3.3.7, which was based on Chapter 4, Section 7 of Guidance on the Methodology for Multi-Modal Studies Volume 2 (DETR, 2000).

Impacts on Townscape

This TAG Unit replaces TAG Unit 3.3.8, which was based on Chapter 4, Section 8 of **Guidance on the Methodology for Multi-Modal Studies Volume 2**(DETR, 2000).

Impact on the Historic Environment

This TAG Unit replaces TAG Unit 3.3.9, which was based on Chapter 4, Section 9 of **Guidance on the Methodology for Multi-Modal Studies Volume 2** (DETR, 2000).

Impact on Biodiversity

This TAG Unit replaces TAG Unit 3.3.10, which was based on Chapter 4, Section 10 of the **Guidance on the Methodology for Multi-Modal Studies Volume 2** (DETR, 2000).

Impact on the Water Environment

This TAG Unit replaces TAG Unit 3.3.11, which was based on Chapter 4, Section 11 of Guidance on the Methodology for Multi-Modal Studies Volume 2 (DETR, 2000).

Appendix A: Alternative Methodology for Local Air Quality

A.1.1 In some cases, a study may initially involve output from a spatially coarse transport model. Because the transport network is not explicitly represented, this type of model cannot provide individual link data and thus cannot be used to carry out the air quality analyses set out in this TAG Unit. However, outputs from this type of model that can be used in the assessment of local air quality, include:

- changes in speed by mode by model zone/study area (as defined in the transport model); and
- changes in passenger car unit/vehicle kilometres travelled by mode by model zone/study area (as defined in the transport model).

A.1.2 This data, in conjunction with appropriate emission factors (see below), can be used to estimate the likely total emissions from a study area, or each model zone within it, resulting from a scheme. This approach may lead to some anomalies in that the relationship between emissions and exposure to air pollution is not always direct and linear, but in most cases will allow a fair comparison between alternative options.

A.1.3 Changes in total emissions can be used as a surrogate or proxy for micro scale air quality impacts. Generally, reductions in total emissions in an area are likely to result in improved air quality, although to what extent will not be clear from an understanding of emissions alone. It is the change in personal exposure to air pollutants that is the key factor in understanding potential health effects. A reduction in total emissions may not in all cases lead to a reduction in the population's exposure to air pollution. For example, schemes which result in more people living and walking near busy road links may result in adverse effects due to greater exposure to air pollutants, even though emissions would reduce overall. These effects are on the micro-scale and, for those studies that are undertaken at a spatially coarse level of assessment, cannot be quantified reliably.

A.1.4 Ideally, in appraising schemes, one would want to include some consideration of the population exposed to changes in air pollution. However, relating population densities to changes in emissions is not a valid approach for assessing air quality impacts and, in fact, may be misleading. The population exposed to a level of emissions does not give an indication as to whether air quality standards are exceeded and therefore whether human health is affected to any significant degree. Emissions of air pollutants can undergo physical and chemical transformation in the atmosphere. Hence, emissions do not always equate directly with the resulting ambient concentrations affecting a population. An understanding of changes in ambient air quality in relation to air quality standards at specific receptor sites and effects on population can only be accurately determined where specific link traffic flows and speeds are available, as in the method set out above.

A.1.5 However, it is important that account is taken of both the magnitude of changes in emissions and where these emissions occur. For example, schemes that switch emissions from town centres to rural areas may result in fewer people being exposed to pollution. Zones within transport models will usually be of differing sizes. Study areas will also differ in size. Therefore, total emissions should be expressed in terms of emission per unit area (e.g. tonnes per km^2 per year). In view of this, the indicator recommended for the appraisal of air quality impacts is the total emission rate per unit area multiplied by a population density for the same unit area.

A.1.6 This approach allows schemes that may yield the same benefits across the study area, in terms of the change in tonnes of emissions, to be differentiated if one tends to favour emissions savings in populated areas. Populations within these zones can be estimated from population databases.

A.1.7 The concept of an "emissions exposure estimate" may be used. The steps to calculate this are outlined in summary below:

i) calculate the total emissions (tonnes per year), for each zone, for NO_x and PM_{10};
ii) estimate the total population in each zone;
iii) for each zone, multiply i) by ii) and divide the result by the area of the zone, expressed in km^2;

A.1.8 The three steps above should be carried out for the without scheme case and for the with scheme case.

iv) for each zone, subtract the value in iii) for the with scheme case from the without scheme case;
v) count the number of positive values in iv) - these are zones in which the scheme is likely to worsen air quality over the without scheme case;
vi) count the number of negative values in iv) - these are zones in which the scheme is likely to improve air quality over the without scheme case;
vii) sum the values in iv) over all zones to create the emissions estimate (do this for NO_x and PM_{10} separately)

A.1.9 In addition, it would also be helpful to identify any Air Quality Management Areas in the study area and comment as to whether the scheme is likely to affect them.

A.1.10 The estimation of total emissions on the basis of vehicle kilometres, speed and emission factors can lead to inaccuracies of which the analyst should be aware. Hence, small differences in totals should not be given undue weight in the decision making process. Some of the reasons for potential errors are given below and the degree to which any particular study might be prone to them should be borne in mind when considering the outputs of any calculations.

- The distribution of speeds about the mean is important in determining total emissions. The relationship of vehicle speed to emission rate per kilometre is not linear and varies with pollutant. A series of transport schemes may well change the distribution of speeds about an un-changing mean. These effects would not be evident if a single mean speed was used.

- The distribution of traffic in relation to populations may be affected by a transport scheme. Without examining micro-scale effects this effect may not be picked up.
- The mix of vehicle types is often crucial in determining the overall emissions of individual pollutants. The level of emission control in the vehicle fleet is important, as is the split in fuel between diesel and petrol.

Appendix B: Alternative approaches for identifying NO_x emissions where the NO_2 limit value is exceeded

Identifying emissions where the NO_2 limit value is exceeded

B.1.1 Information on the NO_x emissions from a scheme can be generated using the methods described for the Regional Assessment in section 3 above. Defra's Pollution Climate Mapping (PCM) model is used to supplement results from fixed monitoring to assess national compliance with pollutant limits and targets in the Air Quality Directive 2008/50/EC and Fourth Daughter Directive 2004/107/EC. The model has been designed to assess compliance with the limit and target values at locations defined within the Directives.[25]

B.1.2 Therefore, results from the PCM model should be used as the basis for identifying where the NO_2 limit value is exceeded. As the PCM model only covers major roads ('A' roads and motorways) in urban areas, there may be situations when none of the links in the identified affected road network are included within the PCM model. In such situations, it is not necessary to separately identify NO_x emissions where the NO_2 limit value is and is not exceeded and all of the change in NO_x emissions or NO_2 concentrations should be valued with the damage cost approach or I-PA.

The link-by-link method for identifying emissions where the NO_2 limit value is exceeded

B.1.3 Where detailed data on link-by-link concentrations and emissions are available, PCM forecasts of NO_2 concentrations by road link can found online at UK Air. The assessment should use the most recent projections that have been made available (note these will be based on the most recently available reference year, which may not be the same as the most recent compliance assessment year). The identified affected road network (preferably defined using the criteria

[25] For example, the Air Quality Directive is clear that assessment should not be undertaken where there is no public access or within 25 metres of major junctions. It should be noted that not all roads in the UK are included in the national assessment; the assessment is conducted in line with the requirements Annex III of the relevant Directive on Ambient Air Quality. Approximately 9000 urban road links are included. These are all in urban areas and are all A roads and Motorways. Their inclusion is based on their classification in the underlying Department for Transport traffic data, only urban A roads and Motorway links are included in the PCM modelling.

from the local air quality analysis) should be mapped against PCM outputs to identify the links where the NO_2 limit value of 40μg/m^3 is exceeded by adding the change in NO_2 concentration from the local air quality assessment (for the closest distance to the road) to the PCM concentrations in the opening year.[26]

There are four possible scenarios that can arise from this process:

- Scheme links do not map onto any PCM modelled links
- Scheme links map onto PCM links which are all compliant with the NO2 limit value both with and without scheme
- Scheme links map onto PCM links which are non-compliant with the NO2 limit value both with and without scheme
- Scheme links map onto PCM links which are compliant with the NO2 limit value without the scheme but non-compliant with the NO2 limit value on some links with the scheme (or vice versa if the scheme reduces emissions).

In all four scenarios, the recommended valuation approach is to use the I-PA or damage cost approach for all links.

B.1.4 The next step is to identify either the NO_2 concentration or the NO_x emissions in the without scheme and with scheme cases on those links where the NO_2 limit value is exceeded. This information should be available from the regional assessment described in section 3.3.

B.1.5 For the purposes of economic valuation, we are primarily concerned with changes in air pollution because of the scheme. If the identified affected road network does not contain any links modelled by the PCM model (scenario 1) or this process does not identify any links exceeding the NO_2 limit value (scenario 2), all the change should be valued in either NO_2 concentrations (I-PA) or in NO_x emissions (damage cost approach).

B.1.6 Where PCM opening year concentrations for a link exceed the NO_2 limit value) all NO_x emissions for that link in the without scheme and with scheme cases should be reported as exceeding the limit, meaning that all of the change on that link can be valued with either the I-PA or damage cost approach.[27]

B.1.7 In scenario 4 (where the scheme results in concentrations for a link moving above or below the NO_2 limit value), potential abatement costs should only be considered for a proportion of the change in NO_x emissions. For this purpose, it is reasonable to assume that NO_2 concentrations increase proportionately with NO_x emissions so that the proportion of the emissions on an exceeding link should be based on the proportion of the change in concentration above (or below) the NO_2 limit value. For example, if the scheme results in concentrations increasing from 38μg/m^3 to 42μg/m^3 (or reducing from 42μg/m^3 to 38μg/m^3), half of the emissions on that link in the without scheme and with scheme cases should be reported as in exceedance. All of the change in emissions on that link

[26] PCM projections are available for the following 'projection years': 2020, 2025 and 2030. Where PCM forecasts are not available for the opening year they should be calculated by linearly interpolating between projection years.

[27] For further detail, see Defra guidance: https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance#working-with-legal-limits.

(above and below the NO_2 limit value) can be valued with either the I-PA or damage cost approach.

B.1.8 The next part of this step of the analysis is to determine how the profile of emissions where the NO_2 limit value is exceeded will change over time. Analysts should take a proportionate approach to how this is assessed. PCM modelling outputs contain forecast concentrations for 2020, 2025 and 2030. Based on the availability of information, detailed link-by-link analysis using these forecasts can be used to determine when compliance with the NO_2 limit value will be achieved for the links identified as exceeding. This should be repeated for as many forecast years as is required, repeating the analysis above for a further forecast year and interpolating and extrapolating between PCM output years to cover the appraisal period.

B.1.9 The TAG Air Quality Valuation spreadsheet also provides an alternative method for determining the proportion of emissions where limit values are exceeded and forecasting this over time. This method uses the total emissions from a scheme over all road links and calculates the probability of emissions occurring areas where the NO_2 limit value is exceeded in a particular year. It then uses this to estimate the proportion of the scheme's total emissions being on a road link in exceedance of the NO_2 limit value in any forecast year.

B.1.10 This method could be used where detailed link-by-link information is not available and cannot be compared with PCM outputs. Therefore, this method might be appropriate for strategic analysis or appraisal of national policies but is not recommended for scheme appraisals where detailed link-by-link information is likely to be available from the local and regional assessments described in this TAG Unit. The method works by basing the profile of NO_x emissions on the profile of PCM forecasts, which provides the percentage of NO_x emissions on roads where the NO_2 limit value is exceeded. These forecasts are given for:

- the percentage of emissions on roads modelled by the PCM (major roads in urban areas) where the limit is exceeded, these are labelled "Urban" in the spreadsheet;
- adjusted forecasts that represent those emissions as a percentage of total NO_x emissions on all major roads (i.e. including emissions on roads not included in the PCM model), labelled "National" in the spreadsheet; and
- for the percentage of NO_x emissions from rail in areas where limits are exceeded.

B.1.11 Analysts should use the set of forecasts most applicable to the scheme being appraised to calculate the NO_x emissions in areas where the NO_2 limit value is exceeded, in the with-scheme and without-scheme scenarios.

B.1.12 Where this approach is used, the TAG Air Quality Valuation spreadsheet can be used to determine the proportion of NO_x emissions in the with and without scheme cases, where the NO_2 limit value is and is not exceeded. The total emissions in the without scheme and with scheme cases for the opening and forecast years should be entered in the "Emissions and concentrations" sheet.

B.1.13 The proportion of emissions on links where the NO_2 limit value is exceeded is calculated depending on the scheme type entered in the Inputs sheet. Analysts should select the appropriate type from the drop-down box. The spreadsheet

will apply the profile of percentages of NOx emissions where the NO2 limit value is exceeded from the PCM and value the changes in emissions with the relevant damage costs over the appraisal period.

B.1.14 Results calculated using this method should be reported in the same way as those for the link-by-link approach and it should be clearly stated in the Appraisal Summary Table that this method has been used (including which set of forecasts were used).

Appendix C: Detail on the derivation of damage costs and impact pathways

C.1.1 The damage cost and impact pathways methodology for economic valuation of air quality is based on research by IGCB(A) that accompanied and informed the Air Quality Strategy Review in 2006.This research is reported in Defra (2006), "An Economic Analysis to Inform the Air Quality Strategy Review Consultation". This report generated a range of monetary values for various key mortality and morbidity benefits, with the aim of using the results to help inform appraisals of air quality impacts. The analysis includes a review of research that provided evidence of people's willingness to pay (WTP) for avoiding the adverse health effects of air pollution. Defra (2023)[28] updated this analysis with new evidence about health, environmental and economic effects of pollutants resulting in updated values for damage costs and impact pathways impacts.

C.1.2 The values presented include impacts of exposure to air pollution on health. This includes both chronic mortality effects (which consider the loss of life years due to air pollution)[29] and morbidity effects (which consider changes in the number of hospital admissions for respiratory or cardiovascular illness). In addition, costs are included in these values for damage to buildings (through building soiling), impacts on materials and economic impacts through productivity. A full explanation of which pathways are included and how these differ by low, central and high sensitivity categories are published on Defra's website[30].

C.1.3 The analysis to support economic valuation of air quality impacts is based on an impact-pathway approach. This approach involves analysis of progression from the emission through dispersion to impacts and finally to monetisation. The impact-pathway approach is recommended best practice as it uses a detailed, location specific approach to quantifying and valuing the impact of air pollution changes. In practice the impact-pathway approach is applied in two ways either through the full impact-pathway modelling (involving bespoke atmospheric

[28] https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-impact-pathways-approach

[29] Although the annual pulse damage costs values represent a change in pollution, by one tonne, for one year, the chronic mortality impacts are followed up for 100 years to capture the more long term effect on health of the pollution change. The damage costs therefore include this 'follow-up' in the values provided.

[30] See footnote 31.

modelling) or through damage costs (which approximate the link between tonnes of emissions and impacts using a number of representative runs of the atmospheric modelling attributing the national level to different modes and area types). Based on the analysis by the IGCB(A), two separate approaches, both derived from impact pathway modelling, are available, depending on the pollutant to be valued.

C.1.4 Research for the IGCB(A) has estimated damage costs by modelling the impacts of changing emissions nationally to calculate the marginal benefit per tonne of emission reduction over a 1 year 'pulse' (the impact of a one-year change in emissions). This analysis has been carried out for different pollutants and sectors, areas and modes to reflect the differing impacts of emissions from different sources (due to varying exposure, dispersion and reaction). This is equivalent to an approximation of the impacts that could be derived from an impact-pathway assessment of a policy on the national scale, and includes both the effect of primary contributions and secondary particles (see glossary). Damage costs calculated in this manner should be applied when measuring changes in NO_x emissions.

C.1.5 For Particulate Matter (PM_{10}), analysis by Defra has shown that around 99.98% of the change in PM_{10} concentrations is expected to occur within 200 metres of the source. Therefore, concentration modelling for this pollutant can be used as a basis for the impact pathway approach, and a single monetary value can be applied to convert change in concentrations to monetary values.

Appendix D: Further guidance on the assessment and presentation of carbon metrics

D.1.1 This appendix provides advice on computing and presenting carbon metrics and supplementary analysis in the Carbon Summary Table (CST) – a standardised format designed to synthesise key carbon-related information for decision makers.

D.1.2 Considering the impacts of a transport scheme on overall carbon emissions is an important part of appraisal. These impacts should be thoroughly considered in a transport business case and form part of an Appraisal Summary Table (AST).

D.1.3 The Carbon Summary Table (CST) additionally allows scheme promoters to present a clear narrative about a scheme's carbon impacts by bringing together information about aggregate carbon impacts (quantified both in tonnes and monetary terms), and carbon impacts disaggregated by whole life carbon stage (capital carbon, operating carbon, and user carbon) and by sector (traded/non-traded). The CST also allows promoters to provide additional relevant information such as the methodologies used to derive carbon estimates,

sensitivities around key assumptions, and mitigation strategies for reducing scheme-associated emissions.

D.1.4 Given the UK's climate commitments, it is important to consider scheme impacts relative to not only a limited transport budget, but also a limited carbon budget. The CST therefore contains carbon metrics that help articulate the trade-offs (or co-benefits) associated with a scheme by illustrating the relationship between carbon and non-carbon impacts.

D.1.5 Analysts are expected to provide, at minimum, a qualitative assessment of the estimated or expected carbon impacts of a scheme at all stages of the business case development process. Reporting should be proportionate to the business case stage and the availability of appraisal outputs.

D.1.6 Where appraisal outputs are not available, but the impacts are still considered to be relevant (for example, if it is not proportionate to quantify capital carbon), values should be reported as "unquantified". Where information is not relevant to the appraisal, sections should be filled with "N/A", along with a justification for why the information is not applicable.

D.1.7 Analysts may present further information about scheme carbon impacts at their discretion. Any such additional analysis should be reported within the Economic Dimension of the business case and highlighted in the "Summary of Carbon Impact" section of the CST.

Carbon metrics

D.1.8 The CST describes three quantitative carbon metrics designed to articulate the trade-offs (or co-benefits) associated with a scheme's carbon impacts: the cost-effectiveness indicator (CEI), the weighted average cost comparator (WACC), and the carbon efficiency metric (CEM).

D.1.9 The CEI captures a scheme's non-carbon impacts (total social impacts minus carbon impacts), while the WACC captures a scheme's carbon impacts. Both measures are defined in terms of a scheme's net impact on carbon emissions (in tCO2e), which allows for the computation of a third measure, the CEM, which captures a scheme's "carbon BCR" and allows for schemes with different emissions profiles to be ranked in terms of their carbon performance.[31] The formulae for computing the three carbon metrics are set out in **Error! Reference source not found.**. The TAG Greenhouse Gases Workbook can help calculate these metrics.

[31] The CEI by itself should not be used to rank schemes with different profiles of carbon emissions over time. Rankings based on the CEI alone would be affected by carbon prices changing over time and would likely yield misleading results. The CEI should be compared to the WACC to determine cost effectiveness of a specific scheme. The CEM can be used for ranking schemes.

Table 17 Carbon metrics summary table

Metric and definition	Formula
Cost Effectiveness Indicator (CEI) Unit: £/tCO2e The net non-carbon social impact of a scheme per tonne of its net impact on carbon emissions (in tCO2e).	$\frac{\text{Net non-carbon social impacts (£)}}{\text{Net carbon impacts (tCO2e)}}$ *Where the net non-carbon social impacts term in the numerator is given by* $\textit{Net non-carbon social impacts} = -\textit{(Net social value (NPV, £)} - \textit{Net carbon impacts (£))}$
Weighted Average Cost Comparator (WACC) Unit: £/tCO2e The monetary value of a scheme's net carbon impacts per tonne of its net impact on carbon emissions (in tCO2e).	$\frac{\text{Net carbon impacts (£)}}{\text{Net carbon impacts (tCO2e)}}$
Carbon Efficiency Metric (CEM) Unit: n/a (ratio) A ratio that captures the value of a scheme's carbon impacts per £ of its net non-carbon social impacts. This is essentially the scheme's "carbon BCR", and it allows different schemes (with potentially different profiles of carbon emissions) to be ranked in terms of their overall carbon cost-effectiveness.	$\frac{\text{WACC}}{\text{CEI}}$

D.1.10 In line with Green Book supplementary guidance, all carbon-related terms (£ or tCO2e) computed for these metrics should be positive for schemes that reduce overall GHG emissions and negative for schemes that increase overall GHG emissions. Table 18, and Figures 2-3 below explain how the carbon metrics should be computed and interpreted for different types of schemes and Box 2 provides illustrative examples.

D.1.11 In this guidance, the net non-carbon social impact of the scheme is the scheme's net social value (NPV) excluding the direct carbon impact from the scheme increasing or decreasing emissions. While this is not a pure non-carbon social impact, as it could include some traded carbon emissions internalised in the NPV term (for example in the transport budget costs component through construction costs), it helps illustrate the cost effectiveness of the carbon impact of the government's investments.[32]

D.1.12 "Wider social impacts" (benefits or disbenefits) can be used as a shorthand way to refer to the term net non-carbon social impacts, where "wider" means the scheme impacts beyond those resulting from directly increasing or decreasing emissions.

[32] If data is available, these traded carbon impacts should be netted off the NPV term. If not, the metrics are still useful, but their CEM ranking properties may be somewhat diminished.

D.1.13 Table 18 shows the four types of transport schemes with different combinations of carbon and non-carbon ("wider") impacts and Figure 2 and Figure 3 show how the carbon metrics should be interpreted for each of these schemes.

Table 18 Types of schemes with different carbon and non-carbon (wider) impacts

	Net decrease in carbon emissions	**Net increase in carbon emissions**
	Type A	**Type C**
Wider social disbenefit	Comparing CEI and WACC helps explain whether the carbon savings are cost effective. CEM helps rank schemes on this basis.	Comparing CEI and WACC or ranking according to CEM is not useful for these types of schemes.
	Type B	**Type D**
Wider social benefit	Comparing CEI and WACC or ranking according to CEM is not useful for this type of scheme.	Comparing CEI and WACC helps explain whether enough wider social benefits are being generated on average to outweigh the carbon disbenefits. CEM helps rank schemes on this basis.

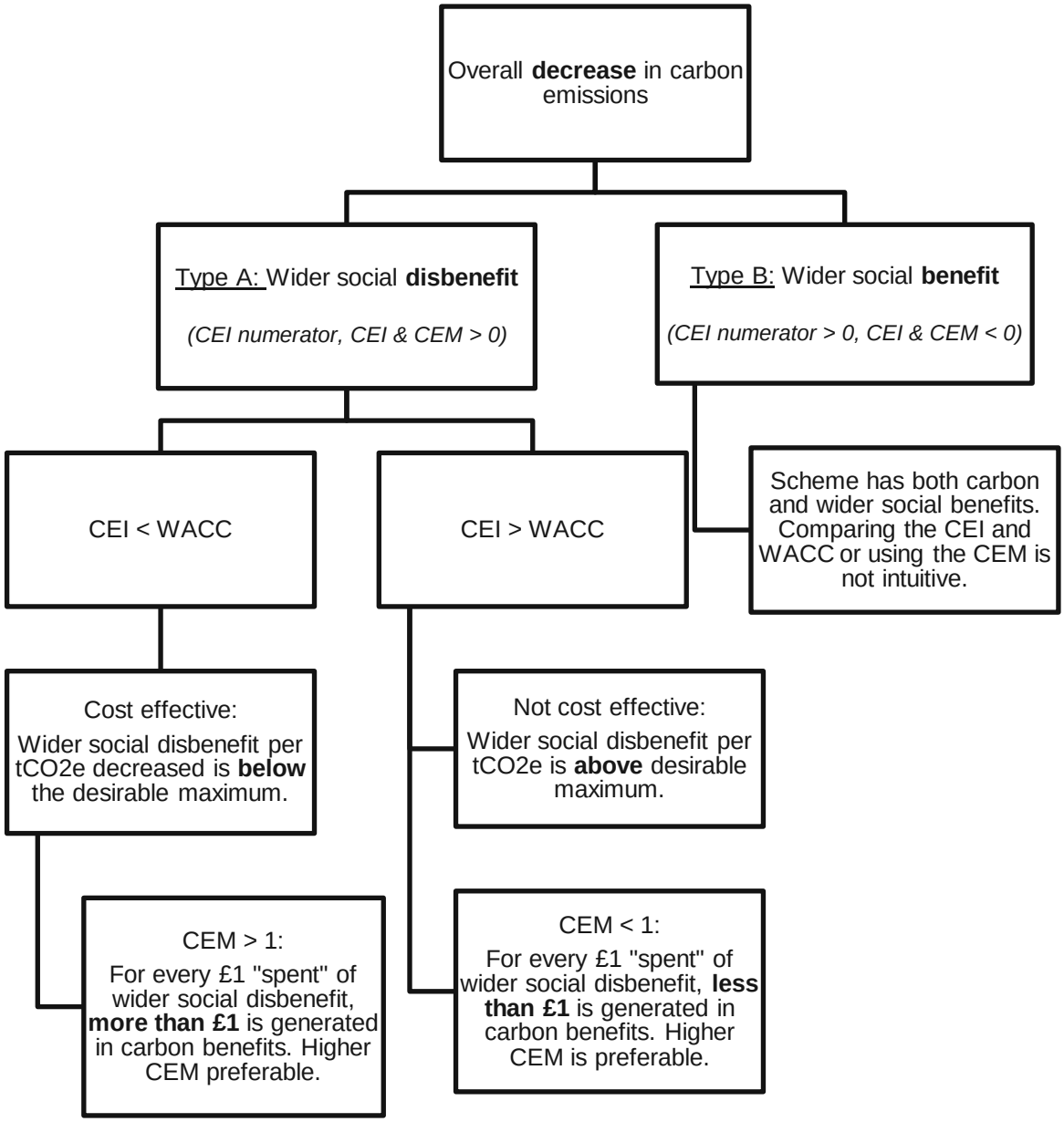

Figure 2 Interpreting the carbon metrics for scheme that decrease carbon emissions overall

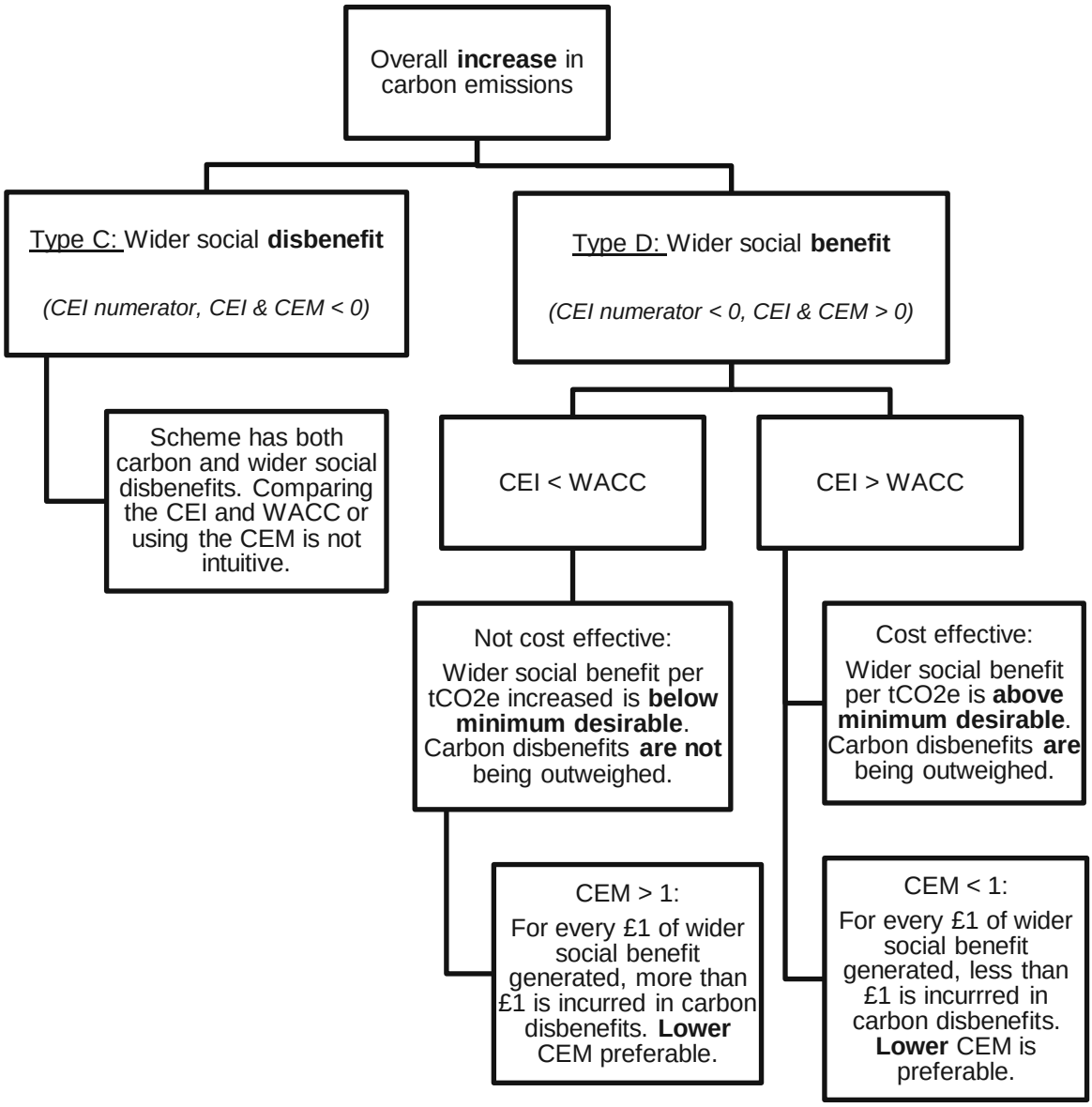

Figure 3 Interpreting the carbon metrics for scheme that increase carbon emissions overall

Box 2 Applying the carbon metrics – illustrative examples

Example 1:

A scheme increases carbon but creates benefits for transport users through reducing commuting time (Type D).

Emissions increase by 10 tCO2e. Scheme benefits (including a £100 carbon disbenefit) are £500, and transport cost is £200. NPV is therefore £300.

The Cost Effectiveness Indicator (CEI) is – (300 – (– 100))/ –10 = 40, which means the scheme generates £40 in wider social benefits per tCO2e it increases. The Weighted Average Cost Comparator (WACC) is – 100/ –10 = 10, which means that £10 is minimum wider social benefits the scheme needs to generate per tCO2e to outweigh the average carbon impact. Since the CEI > WACC, the carbon impact is being outweighed.

Carbon Efficiency Metric (CEM) is 0.25 (WACC/CEI), meaning £0.25 in carbon disbenefits for each £1 of wider social benefit. Comparing this with another scheme with CEM 0.15, the second scheme is preferable for its lower carbon disbenefits for each £ in wider social benefits.

Example 2:

A scheme that decreases carbon through transport electrification but has wider social disbenefits (Type A).

Emissions decrease by 20 tCO2e. Scheme benefits (including a £200 carbon benefit) are £500, and transport cost is £400. NPV is therefore £100.

The Cost Effectiveness Indicator (CEI) is – (100 – 200)/20 = 5, which means the scheme reduces carbon at a wider social cost of £5 per tCO2e saved. The Weighted Average Cost Comparator (WACC) is 200/20 = 10, which means that £10 is the maximum it is desirable to spend (in wider social disbenefits) on average to reduce carbon. Since CEI < WACC, carbon is being reduced in a cost effective way.

The scheme's Carbon Efficiency Metric (CEM) is 2 (WACC/CEI), which means that it has £2 in benefits from reducing emissions for each £1 spent in wider social disbenefit. Comparing this with another scheme with CEM 1.5, the first scheme is preferable because it has more carbon benefits for each £ spent in wider social disbenefit.