A303 Amesbury to Berwick Down

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8.52.1 – Written summary of oral submissions put at Cultural heritage, landscape and visual effects and design hearing on 21 August 2019

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Planning Act 2008

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A303 Amesbury to Berwick Down

Development Consent Order 20[**]

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1 Introduction

1.1.1 This note summarises the submissions made by Highways England ("the Applicant") at the Cultural Heritage, landscape and visual effects and design hearing held on 21 August 2019 ("the Hearing") in relation to the Applicant's application for development consent for the A303 Amesbury to Berwick Down project ("the Scheme").

1.1.2 Where the Examining Authority ("the ExA") requested further information from the Applicant on particular matters, or the Applicant undertook to provide further information during the hearing, the Applicant's response is set out in this document. This document does not purport to summarise the oral submissions of parties other than the Applicant, and summaries of submissions made by other parties are only included where necessary in order to give context to the Applicant's submissions in response, or where the Applicant agreed with the submissions of another party and so made no further submissions itself (this document notes where that is the case).

1.1.3 The structure of this document follows the order of items published by the ExA on 14 August 2019 ('the Agenda"). Numbered agenda items referred to are references to the numbered items in the Agenda. The Applicant's substantive oral submissions commenced at item 3 of the agenda, therefore this note does not cover items 1 and 2 on the agenda which were procedural and administrative in nature.

Written summary of the Applicant's oral submissions

3. THE WORLD HERITAGE SITE

3.1. Harm to the Outstanding Universal Value (OUV)

Agenda Item	Highways England response
i. Harm to the OUV and its place in the overall acceptability of the Proposed Development. Discussion.	**The Examining Authority** invited the Applicant to comment on submissions from interested parties that granting consent for the Scheme would lead to a breach of international obligations. **Reuben Taylor QC, counsel for Highways England**, explained that Highways England has addressed compliance with international obligations (with respect to the World Heritage Convention) fully in writing. Mr Taylor QC directed the ExA to the Applicant's response to the Examining Authority's Written Question G.1.1 [REP2-021], the Applicant's Written Summaries of oral submissions at Cultural Heritage Issue Specific Hearings (ISH2) [REP4-030] (specifically Agenda Items 3(i), 3(v), 3(vi) and Appendix A to that document), and items 34.1.47 – 34.1.62 of the Applicant's response to comments submitted at deadline 4 [REP5-003]. **Mr Taylor QC** submitted that the legal submissions put forward by interested parties (such as Stonehenge Alliance, who were referred to specifically by the ExA) in this respect are flawed and the approach that Highways England has set out is the correct approach in law. Mr Taylor QC explained that the approach taken by the Applicant to the assessment has followed the approach it says is correct in law. **Mr Taylor QC** explained that if submissions such as those from Stonehenge Alliance were correct, this would mean that the National Policy Statement for National Networks ("**NPSNN**") contains an approach that would be unlawful. That was not a submission made by any party, including ICOMOS UK, on the consultation of the NPSNN. (this point is expanded upon further Applicant's Written Summaries of oral submissions at Cultural Heritage Issue Specific Hearings (ISH2) [REP4-030] (specifically Agenda Items 3(vi) and Appendix A). Various interested parties made submissions with respect to compliance with the international obligations under the World Heritage Convention.

	In response to submissions from **Victoria Hutton on behalf of the Consortium of Archaeologists and Blick Mead Project Team**, **Mr Taylor QC** explained that it is not correct to say that any harm to OUV would result in a breach of international obligations. Mr Taylor QC again referred to where the Applicant's position is set out in earlier submissions (see above cited references). Mr Taylor QC explained that the World Heritage Convention links into the decision-making process, by virtue of section 104(4) of the Planning Act 2008, requiring the application to be decided in accordance with the NPSNN unless doing so would lead to the UK being in breach of any of its international obligations. This then requires a consideration of paragraph 5.129 of the NPSNN, where the focus is on the "*particular nature of the significance of the heritage asset and the value that they hold for this and future generations*", and paragraph 5.131, where it is stated that "*the Secretary of State should give great weight to the asset's conservation*" and "*The more important the asset, the greater the weight should be*", which bestows particular importance in the context of a World Heritage Site. Mr Taylor QC explained that the NPSNN then requires a consideration of any adverse impact on the significance of the World Heritage Site, as a heritage asset. Highways England's position is that overall the Scheme results in enhancement of the significance of the World Heritage Site ("**WHS**"). If, however, the decision maker were to conclude some harm would be caused to the significance of the WHS, the provisions at paragraph 5.131 and following in the NPSNN would have to be applied. This requires a consideration of whether the harm is substantial or less than substantial, and then for that harm to the significance of the asset to be weighed against the public benefit accordingly. Mr Taylor QC noted that there is a different approach depending on the level of harm, but that ultimately there is a balance required. Mr Taylor QC submitted that Ms Hutton's position, in light of her submissions that any harm to OUV is a breach of the World Heritage Convention, must be that the policy approach set out in the NPSNN is in breach of the World Heritage Convention. Mr Taylor QC explained that even if the approach set out in the NPSNN did result in a breach of international obligations (on Ms Hutton's case, though this is not the Applicant's position), section 104 of the Planning Act 2008 does not require the decision maker to simply set the NPSNN to one side. The effect of section 104(4) is that the decision maker is no longer required to determine the decision in accordance with the NPS (to the extent that doing so puts the UK in breach of international obligations); a decision still has to be made. There is no guidance as to how that decision should be undertaken, other than perhaps in accordance with section 104(7), which requires a balance to be struck and for the decision maker to consider the various adverse and beneficial impacts of the scheme, including the implications for relevant international obligations. This would be the effect, were Ms Hutton's submissions correct, which the Applicant submits they are not. **George Lambrick of the Council for British Archaeologists** ("**CBA**") made submissions as to how he considers paragraph 5.139 of the NPSNN should be interpreted, stating that the case of Hayes v York CC (cited by Highways England in its previous response on this point at Appendix B to its oral summary of the ISH on Cultural Heritage [REP4-030]) was not definitive.

	Post hearing note: The CBA has also made this assertion in its late written submission following Deadline 6 [REP6-084] and the Applicant has responded to it at this Deadline 8 as follows. The Applicant does not accept that the judgment of Mr Justice Kerr in Hayes v York CC is limited to its facts. The key text of the judgment on which the Applicant relies (at paragraph 81, as is set out in Appendix B to its oral summary of the ISH on Cultural Heritage [REP4-030]) is set out in the portion of the judgment that gives general guidance on the correct approach to the interpretation of the NPPF. Mr Justice Kerr's judgment clearly indicates where that general discussion of the law ends and the specific application of those general principles to the facts of this case begins (please see paragraph 83 which starts "In the present case…"). Moreover, Mr Justice Kerr's judgment gives no indication that it is limited to its facts; in fact, Mr Justice Kerr makes clear that his judgment is the first (and to our knowledge, remains the only) judgment on the interpretation of the relevant paragraph of the NPPF (please see paragraph 1 of the judgment). In such circumstances, if Mr Justice Kerr had intended to limit his judgment to the case in hand, we would expect this caveat to have been explicitly stated (as is normally the case in judgments). No such caveat exists. Furthermore, we do not believe that the CBA's interpretation of paragraph 85 is accurate. Our interpretation of paragraph 85 is that Mr Justice Kerr doubts that it is valid, generally, to draw any distinction between (a) weighing the public benefits of recording archaeological finds in the planning balance and (b) recording as mitigation which reduces the detriment caused by an already justified development – but in any event this distinction (if it does exist) should be rejected (which is what happened in the Hayes case). That is not the same as or akin to limiting the application of the entire judgment to the facts of the Hayes case, particularly in the context where Mr Justice Kerr has adopted the approach noted above of clearly stating where the general discussion stops and the specific discussion begins (at paragraph 83). Furthermore, in relation to the second bullet point made by the CBA [in REP6-084, on this point], the Applicant considers that the fact that the NPPF and NPSNN have not been amended since the Hayes v York CC is evidence that the accepted interpretation of the NPPF is that which has been set out in this case – i.e. "the last sentence of that paragraph [paragraph 141 of the NPPF] only makes good sense if interpreted so that the words "should not be a factor" are taken to bear the meaning "should not be a decisive factor". The legal position, in the absence of any change to policy, is comprised of the existing policy statements and the case law as to their interpretation. If the judgement in Hayes v York CC did not reflect the intention of those policy statements, there has been the opportunity to clarify that in subsequent revisions. That has not occurred, as the CBA point out. In response to further submissions made by **Stonehenge Alliance** in relation to balancing harm to the WHS against the public good, **Mr Taylor QC** pointed to the scheme benefits as identified in the Case for the Scheme and NPS Accordance [APP-294]. In relation to submissions made by **ICOMOS UK** in relation to balancing harm to different parts of the WHS, Mr Taylor QC referred the Examining Authority to the ICOMOS Guidance on Heritage Impact Assessments for Cultural World Heritage Properties (January 2011) ("**ICOMOS Guidance**"), in particular:

	(a) Paragraph 5.10 noted that the HIA report needs to show the assessment for each individual attribute; and (b) Appendix 4 which sets out the potential contents for a HIA, referring in section 7 to the assessment and evaluation of overall impact of the proposed changes. That section is to include a consideration of all impacts on all attributes and also include an evaluation of the overall significance of effect. It is clear from this that a balancing approach is to be adopted. **The Examining Authority** asked the Applicant to explain how its assessment of effects on Integrity and Authenticity sat alongside the assessment of effects on the OUV of the WHS, and how those different assessment outcomes were weighed against each other. **Chris Moore, on behalf of Highways England**, explained that Integrity and Authenticity are additional criteria for inscription of the WHS. The ICOMOS Guidance makes clear that Integrity and Authenticity must also be taken into account in arriving at an overall impact on the WHS as a whole (paragraph 5-12 on page 10 of the ICOMOS Guidance). Mr Moore explained that key factors for Authenticity are form and decision, materials and substance, location and setting. As recorded in paragraph 9.9.12 of the Applicant's HIA Scoping Report, "*In relation to the Stonehenge, Avebury and Associated Sites WHS, the primary factors that express its authenticity overlap with the attributes of OUV*". Mr Moore explained that in terms of Integrity, this concerned intactness of the whole of the OUV and its attributes, including considerations of how the property suffers from adverse development and neglect. Mr Moore explained that Highways England's approach to the assessment of Integrity and Authenticity was set out in its HIA Scoping Report, which was provided to ICOMOS (international, as distinct from ICOMOS UK), and which ICOMOS (international) subsequently confirmed in their mission report, was appropriate and fit for purpose. Mr Moore directed the Examining Authority to paragraphs 9.4.41-9.4.45 of the Heritage Impact Assessment ("**HIA**") [APP-195] regarding the impact of the Scheme on the Integrity of the WHS, and paragraphs 9.4.46 – 9.4.50 regarding the impact of the Scheme on the Authenticity of the WHS. Mr Moore explained that in the assessment equal weight is given to Integrity and Authenticity as to OUV; Integrity and Authenticity are considered in parallel to OUV, and there is no overall balancing of the three elements, instead three conclusions are reported, being the overall impact on OUV, impact on Integrity and impact on Authenticity. **Post hearing note:** Susan Denyer of ICOMOS UK made submissions that Integrity and Authenticity are part of OUV and not separate to it. The UNESCO Operational Guidelines for the Implementation of the World Heritage Convention (2017 issue, UNESCO reference WHC.17/01, dated 12 July 2017) set out the criteria for the assessment of Outstanding Universal Value at paragraph 77, noting that a property is of OUV if it meets one or more of ten criteria: criteria (i) to (vi) relate to cultural heritage values. The Stonehenge, Avebury and Associated Sites WHS is inscribed as of OUV under criteria (i), (ii) and (iii).

	The Operational Guidelines go on in paragraph 78 to note, 'To be deemed of Outstanding Universal Value, a property must also meet the conditions of integrity and/or authenticity and must have an adequate protection and management system to ensure its safeguarding.' The conditions of Integrity and Authenticity relevant to cultural WH properties are described in paragraphs 79 to 89 of the Operational Guidelines. In Highways England's submission, therefore, assessment of the Authenticity and Integrity of a property amounts to a condition additional to the criteria for inscription: a property needs to meet these conditions in order to be deemed of OUV. Paragraph 82 of the Operational Guidelines states, 'Properties may be understood to meet the conditions of authenticity if their cultural values (as recognized in the nomination criteria proposed) are truthfully and credibly expressed through a variety of attributes…'. Paragraph 82 also provides examples of these, some of which were referred to by Mr Moore at the issue specific hearing. In terms of the approach taken to assessment of impacts on Integrity and Authenticity in the HIA, Paragraph 5.4.11 of the HIA [APP-195] acknowledges that, '… Attributes are greater than individual components and include the characteristics which convey the values identified in the Statement of OUV'. Paragraph 5.4.17 of the HIA states, 'In relation to the Stonehenge, Avebury and Associated Sites WHS, the primary factors that express its Authenticity also relate to the Attributes of OUV…'. In section 11 of the HIA, equal weight is given to the impact on Integrity and Authenticity - these tests are considered alongside the impact on OUV by attribute. **Mr Taylor QC** reiterated that the HIA, read fairly and as a whole, adopts a methodological approach in line with the HIA Scoping Report (which was considered appropriate by ICOMOS (international)). The HIA very clearly and overtly assesses the impact of the Scheme against each attribute of OUV and against the criterion of Integrity and Authenticity. The HIA does the very things required by the guidance.

3.2. World Heritage Committee adopted decision and report, July 2019

Agenda Item	Highways England response
i. The report's criticism of the focus of the Proposed Development's analysis on measuring and aggregating its impact on individual components, and of its justification based on assessing whether the proposal is an improvement, rather than the best	**The Examining Authority** invited the Applicant to respond in relation to (i) the World Heritage Committee report's criticism of the focus of the Scheme's analysis on measuring and aggregating its impact on individual components, and (ii) of its justification based on assessing whether the proposal is an improvement, rather than the best available outcome for the property. **Reuben Taylor QC, on behalf of Highways England**, referred the Examining Authority to where the Applicant had previously addressed the decision of the World Heritage Committee at its response to comments submitted at Deadline 4 [REP5-003] item 10.1.3, and the Applicant's answer to first written question G.1.1 [REP2-021] regarding the state party's obligations under the World Heritage Convention. Mr Taylor QC reiterated that the methodology set out in the HIA Scoping Report was considered acceptable by ICOMOS (international), as reported in the Final Report on the joint World Heritage Centre / ICOMOS Advisory mission to Stonehenge,

available outcome for the property.	Avebury and Associated Sites [REP1-008]. Further, the methodology utilised in the HIA had been discussed and agreed in detail with Highways England and HMAG. Mr Taylor QC submitted that there was nothing in the ICOMOS Guidance requiring that the Scheme must achieve the best available outcome, nor anything that indicates the method used by Highways England in its HIA is not appropriate. Mr Taylor QC explained that the design of the Scheme has been undertaken in iterative way with full consideration of the World Heritage Convention, the OUV of the WHS, and the Integrity and Authenticity of the WHS. The Examining Authority was directed to Chapter 3 of the ES (Alternatives), see ES Ch6 [APP-044, Section 6.8 and Table 6.9] and HIA [APP-195; Section 8.2]. Submissions were made on this point by **George Lambrick of CBA, Susan Denyer of ICOMOS UK, and Ms Hutton on behalf of the Consortium of Archaeologists and Blick Mead Project Team**. In response, Mr Taylor QC explained that in terms of whether there was an obligation to produce the best possible solution, the starting point was the World Heritage Convention. The Convention's obligations are to protect and conserve the WHS, and Highways England's position is that its Scheme achieves that objective because it results in enhancement of the OUV of the WHS and an overall slight beneficial effect on the WHS as a whole. Mr Taylor QC submitted that it was difficult to comprehend how an objective to achieve the best possible outcome, which would appear to go beyond enhancement, can be identified from an obligation to protect and conserve the WHS. With respect to submissions made by Ms Hutton in relation to the degree of significance or weight that would be placed on the World Heritage Committee's decision, Mr Taylor QC said that her submissions should be treated with real caution. Mr Taylor QC explained that the World Heritage Committee is not a decision-making body set up to determine whether developments around the world are acceptable in relation to the World Heritage Convention. Mr Taylor QC submitted that the views of the World Heritage Committee should be treated as the views of a consultee, to be given appropriate weight by a decision maker. There are various factors to be taken into account when determining how much weight to give to the Committee's views. Mr Taylor QC submitted that to say the views of the Committee should be treated as determinative (as was Ms Hutton's submission) was a dangerous approach and should be rejected. Mr Taylor QC explained that the evidence base before the World Heritage Committee was very different to that before the Examining Authority and Secretary of State. The World Heritage Committee had been provided with the State of Conservation Report prepared by DCMS in February 2019 [REP1-015]. The Examining Authority has also been provided with that document, but also many more documents, not least a detailed analysis of longer tunnel options in response to first written question AL.1.29 and a break down of costs associated with the longer tunnel options in response to first written question AL.1.30 [REP2-024]. Mr Taylor QC submitted that that information post dates the information taken into account by the World Heritage Committee. Mr Taylor QC queried whether the statements in the World Heritage Committee's report reveal an approach that is inconsistent with the ICOMOS Guidance (that is, taking an overall view of OUV once benefits and harm have been assessed). Mr Taylor QC noted that the language used, in terms of "best available outcome", was not language that comes from the

	World Heritage Convention nor the NPSNN, and it does not sit with the ICOMOS Guidance. Mr Taylor QC submitted that those factors lead to a conclusion that to treat the World Heritage Committee's decision as determinative would be unwise. In response to a submission from **Kate Fielden of Stonehenge Alliance** that the World Heritage Committee's decision must be seen as determinative, as they could remove the WHS listing, Mr Taylor QC noted that there is nothing in the Committee's report that indicates any intention to remove the designation of WHS from the Stonehenge, Avebury and Associated Sites WHS should the Scheme be allowed.
ii. The report notes that a longer tunnel is technically feasible but is not proceeding because of cost, etc. However, a detailed analysis of the benefits compared with the costs of a longer tunnel is absent from the application.	In terms of the suggestion that in the agenda item that "*a detailed analysis of the benefits compared with the costs of a longer tunnel is absent from the application*", **Reuben Taylor QC** explained that this point had been addressed with respect to (i) of this Agenda Item. The World Heritage Committee's comments were based on the evidence available to it. The evidence base has moved on compared to that placed before the Committee such that the Examining Authority and the Secretary of State have a much more detailed position set out before them, not least in response to first written questions AL.1.29 & AL.1.30 [REP2-024]. **The Examining Authority** questioned the level of detailed analysis that had been undertaken with respect to the costs and benefits for a longer tunnel. Mr Taylor QC disagreed with the Examining Authority in this respect, submitting that very great detail had been provided in the responses cited. Mr Taylor QC explained that there was also a clear pattern in the optioneering process that has been provided to the Examination that has addressed the longer tunnel in greater detail (as explained, for example, in Chapter 3 of the Environmental Statement [APP-041]). Mr Taylor QC submitted that the Applicant had presented a breadth of information which is more than sufficient to discharge the evidential burden in this respect. In response to a submission from **George Lambrick of CBA**, about an alternative surface route to the South, Mr Taylor QC explained that this is an option that was raised in previous reports from ICOMOS and the World Heritage Committee, but which is no longer pursued by ICOMOS / the Committee and is not referred to in the recent decision. In response to a submission from **Kate Fielden of Stonehenge Alliance**, that cost was a key factor in the consideration of alternatives, Mr Taylor QC disagreed that Highways England had not carried out an assessment of alternatives. By way of example, he pointed to Chapter 3 of the Environmental Statement [APP-041]. Mr Taylor QC explained that in terms of costs being an overriding consideration, the position (as set out clearly in response to first written questions AL.1.29 and AL.1.30 [REP2-024]) is that to extend the tunnel further to the west provides minimal benefit in heritage terms and would increase cost in a very significant way. It is unfair to characterise the analysis as purely a matter of cost, when other benefits and impacts have also been carefully considered. **Keith Nicholls of the Department for Digital, Culture, Media and Sport** ("**DCMS**") noted that DCMS continues to support the core elements of the application with respect to the impact on the WHS. Mr Nicholls indicated that DCMS disagreed with specific elements of the World Heritage Committee's decision, in particular paragraphs 4 and 5. Mr Nicholls stated that DCMS disagreed that the Scheme should not proceed, and rejected the suggestion in paragraph 5 that the length of the

	tunnel should be extended. Mr Nicholls agreed with submissions made by Mr Taylor QC that cost is not an overriding consideration, but noted that a fundamental factor for DCMS was value for money to the taxpayer. Mr Nicholls noted that, whilst DCMS had wider obligations including those to the UK taxpayer, the World Heritage Committee was understandably not concerned with the cost to the UK tax payer of a longer tunnel without commensurate benefits. Mr Nicholls submitted that DCMS did not believe the Scheme would put the UK in breach of its international obligations. He noted that the overall impact of the Scheme would be to strengthen and enhance the WHS. Mr Nicholls stated that DCMS accepts that within that overall benefit there are some minor adverse impacts to attributes of OUV, and expects Highways England to minimise those by continuing to work with Historic England and other heritage stakeholders. Mr Nicholls also noted that the position of the new heritage minister would be confirmed in writing before the end of the Examination. **Ms Hutton** made submissions on behalf of the **Consortium of Archaeologists and Blick Mead Project Team**, that state parties were required to ensure the protection and conservation of WHSs to the utmost of their resources, citing the Australian High Court decision in the Tasmanian Dams Case. Mr Taylor QC noted that this was a gross oversimplification of the effect of the Tasmanian Dams Case. Mr Taylor QC referred the Examining Authority to where the Applicant had addressed this point in detail previously. **Post hearing note**: In this regard the Examining Authority is directed to Appendix A of the Applicant's Written Summaries of oral submissions at Cultural Heritage Issue Specific Hearings (ISH2) [REP4-030]. In that Appendix, the Applicant has set out paragraph 41 of the decision of Brennan J in the Tasmanian Dams Case, which was relied upon by Ms Hutton at Issue Specific Hearing 2. As set out in Appendix A: "*Ms Hutton referred to paragraph 41 of Brennan J's judgement and cited it as authority that there was no discretion with respect to the implementation of Article 4 of the World Heritage Convention. This position is, however, more nuanced than that, and what the case law establishes is that whilst there is a legal obligation imposed by the World Heritage Convention, it is not an absolute one. There is a discretion as to the manner of the performance of that obligation provided that, according to the terms of the Vienna Convention Article 31 it is interpreted in good faith.* *It can be seen from extracts of key passages of the judgements in the Tasmanian Dam Case that the use of the language of obligation – in particular in the paragraph selected by Ms Hutton - stemmed from the central point at issue in the case: whether the Convention imposed obligations on Australia. It is clear from a wider reading of the judgements and subsequent case law that the members of the High Court consistently accepted that there was a discretion in the manner of performance of the obligation, allowing for the balance provided for in the UK's national policy statements, NPPF, Planning Act 2008 provision, and established approach to assessment of impacts on heritage generally and the balancing of factors in decision making... "*

	In Appendix A the Applicant set out the key principles that can be taken from the Australian case law with respect to the World Heritage Convention, and these are reproduced here: Key principles based on the above Australian case law are as follows: 1. The World Heritage Convention imposes real legal obligations on State Parties. Whilst there is no discretion as to whether a State Party will abstain from taking any steps in discharge of the "duty" referred to in Article 4 of the Convention, there is discretion as to the manner in which the duty is performed, for example, it is for each State Party to decide the allocation of its resources. This is consistent with the imprecise nature of the obligations. 2. Despite the wording of Article 4 of the World Heritage Convention, requiring that each State Party does "all it can" to protect and conserve cultural heritage "to the utmost of its own resources", the Convention has to be read as a whole. Article 4 therefore has to be read subject to the wording of Article 5. 3. Article 5 sets out the specific steps a State Party can take in order to comply with the World Heritage Convention. It introduces those steps by stating that "each State Party to this Convention shall endeavour, so far as possible, and as appropriate for each country …" to carry them out. 4. Under the World Heritage Convention, then, State Parties do not envisage absolute protection, but a level of protection of WHSs taking account of economic, scientific and technical limitations, and the integration of heritage protection into broader economic and social decision making. 5. Article 5 establishes that how the World Heritage Convention is implemented in practice is up to each State Party. The World Heritage Convention does not impose any specific action or binding commitment on a State Party. It is left to the State Party to determine the extent of the obligations and the mode of their performance. There is discretion as to what steps the State Party takes and "considerable latitude" as to their precise actions. 6. The World Heritage Convention is to be interpreted in good faith and in accordance with the ordinary meaning of the words of the Convention in their context and in the light of the Convention's object and purpose. It is clear from the case law and the principles it gives rise to, that it is an oversimplification of the position for Ms Hutton to simply that that there is a requirement in the World Heritage Convention for the UK to protect and conserve the WHS to the utmost of its resources, without any consideration of the Convention as a whole and how case law indicates it should be interpreted.

3.3. *Heritage Impact Assessment (HIA)*	
Agenda Item	**Highways England response**
i. The HIA's approach to the effects of the Proposed Development on the OUV given that four of the seven attributes which together express the OUV of the site concern spatial relationships.	**The Examining Authority** noted that this Agenda Item related to measuring the impact of the Scheme on individual components and the spatial landscape, referring to criticism from interested parties that the Applicant's approach had been focussed on individual aspects rather than the overall landscape approach. **Reuben Taylor QC, on behalf of Highways England**, referred the Examining Authority to the ICOMOS Guidance for undertaking heritage impact assessments, in particular: (a) Paragraph 5.10, which notes that the HIA report needs to show the assessment for each individual attribute; and (b) Appendix 4 which sets out the potential contents for a HIA, referring in section 7 to: *"Assessment and evaluation of overall impact of the proposed changes* *This part should set out an assessment of specific changes and impacts on the attributes of OUV and other heritage assets. It should include a description and assessment of the direct or indirect impacts, including physical impacts, visual, or noise, on individual heritage attributes, assets or elements and associations, and on the whole. Impact on OUV should be evaluated through assessment of impact on the attributes which convey the OUV of the site.* *It should consider all impacts on all attributes; professional judgement is required in presenting the information in an appropriate form to assist decision-making. It should also include an evaluation of the overall significance of effect – overall impact - of the proposals for development or change on individual attributes and the whole WH property. This may also need to include an assessment of how the changes may impact on the perception of the site locally, nationally and internationally."* Mr Taylor QC submitted that the Applicant's HIA had been undertaken, following the ICOMOS Guidance, and that as a result the Applicant did not understand why the World Heritage Committee had raised these points. Mr Taylor QC noted that the Applicant had undertaken a detailed assessment in accordance with the ICOMOS Guidance on heritage impact assessments and was the only party to present a HIA to the Examination. **Chris Moore, on behalf of Highways England**, added that the method used in applying the ICOMOS Guidance followed the Applicant's HIA Scoping Report (referred to earlier as having been deemed appropriate by ICOMOS (international)). The HIA Scoping Report provided at paragraph 9.3.5 – 9.3.6: "*A qualitative assessment of the likely impact of the Scheme on the fabric and setting of the designated and non-designated discrete assets that contribute to OUV will be undertaken. This will characterise the heritage resource and identify assets that convey attributes that express the OUV. The potential impacts of the removal of parts of the existing A303, construction of the new highway sections and tunnel portals, and the operation of the new road on the fabric and setting of the designated and*

	non-designated assets that contribute to OUV will be assessed. The 'do nothing' scenario will also be assessed, with reference to the 2015 WHS Management Plan [5] and the 2012 WHS Condition Survey [38]. *From this the overall impact of the Scheme upon the attributes of OUV of the World Heritage property and its Integrity and Authenticity will then be assessed."* Mr Moore confirmed that the impact on the OUV of the WHS has been assessed in line with the HIA Scoping Report, and as a result the OUV has been assessed by considering the attributes that contribute to the OUV, in line with the ICOMOS Guidance. Mr Moore also noted that the HIA Scoping Report also includes Table 1 which sets out a summary of approaches to the assessment of attributes of OUV and outlines the approach to the assessment of each attribute. In response to a query from the Examining Authority about paragraph 2.2.3 of the DAMS, and why Attribute 2 did not mention the spatial relationship between physical remains, Mr Moore explained that those principles set out in the DAMS relate specifically to archaeological remains, and the reference to Attribute 2 is cited specifically in that context (that is, in relation to archaeological remains rather than spatial relationships). **Professor Jacques of the Consortium of Archaeologists and Blick Mead Project Team** made submissions in relation to Blick Mead. Mr Taylor QC reiterated Highways England's position that the only potential impact from the Scheme on Blick Mead is in relation to a change in groundwater, and the Applicant has set out in detail why the Scheme will not have any materially adverse impact on hydrological conditions at Blick Mead.
ii. Integrity and authenticity	This Agenda Item was covered above under the discussion in relation to Agenda Item 3.1(i).
iii. Harm to the OUV from effects outside the boundaries of the World Heritage Site	**Reuben Taylor QC, on behalf of Highways England**, directed the Examining Authority to its response to second written question LV.2.1 [REP6-030], which respect to Long Barrow Junction (in particular responses to parts (vi) and (vii)) and to its response to first written question CH.1.58 [REP2-025].

4. OUTLINE ENVIRONMENTAL MANAGEMENT PLAN (OEMP) (DL6 VERSION [REP6-011 AND REP6-012])

4.1 Approvals/ agreements/ consultation

Agenda Item	Highways England response
i. MW-G7 and MW-CH1 note the Heritage Management Plan is to be approved by Wiltshire Council, as are the Heritage Method Statements (amend MW-G8) and Site Specific Written Schemes of Investigation (SSWSI). However, approval of the type of fencing (MW-CH3); surfacing (MW-CH14); monitoring of heritage assets arrangements (MW-CH7); the Ground Movement Monitoring Strategy (MW-CH8); the vibration control measures (PW-NO14 and MW-NO13); the Landscape and Ecology Management Plan (LEMP) (MW-LAN1) and the Arboricultural Mitigation Strategy (MW-LAN3) remains the responsibility of Highways England. Discussion.	**Reuben Taylor QC, on behalf of Highways England**, explained that the Applicant had reflected further on the current mechanisms for approvals of the plans required to be produced by the OEMP, having had regard to comments and queries from interested parties and the Examining Authority, and as a result, Highways England proposes that the DCO is amended to provide that the CEMP, and the management plans under it (including those specified in the Agenda Item) be subject to Secretary of State approval. This would follow the general position in the vast majority of Highways England DCOs to date and so it is supported by the Secretary of State. **Post hearing note**: For clarity, the plans that Secretary of State approval would apply to are set out below: • Ground Movement Monitoring Strategy (MW-CH8) • Landscape and Ecology Management Plan (LEMP) (MW-LAN1) • Arboricultural Mitigation Strategy (MW-LAN3); • Vibration control measures (PW-NO14 and MW-NO13) - Vibration control measures will be included in the Noise and Vibration Management Plan, which will also be subject to SoS approval. The exception to the rule is the Heritage Management Plans, SSWSIs and Method Statements, which are subject to approval by Wiltshire Council after consultation with Historic England and the other members of HMAG as appropriate (as provided for in the DAMS). Clearly this exception to the rule is justified by the special circumstances of the Scheme in the WHS. Before submitting the relevant documents to the Secretary of State for approval, Highways England would be subject to the consultation obligations already contained in the OEMP. The obligations around 'mini consultation reports' would still bite, in Requirement 11 and MW-G5 of the OEMP, subject to minor modifications to ensure those obligations would work as part of the proposed mechanism for approvals. This proposed approach has been discussed with Wiltshire Council at a meeting on 15 August 2019 ahead of this hearing and it has been confirmed the Council is content with this approach and is not seeking to approve anything more than has already been offered. Highways England will give further detail in written submissions, as well as the necessary adjustments to the OEMP, at Deadline 8.

	All of the other items are the subject of detailed design commitments, principles and consultation obligations in the OEMP, meaning that they are sufficiently regulated without the need for any further approval. In the case of fencing and surfacing forming part of assets to be adopted by Wiltshire Council as local highways authority, they will be regulated by provisions in the highways agreement to be entered into between Highways England and Wiltshire Council. **Richard Moules, on behalf of Wiltshire Council**, confirmed that the amendments were welcomed by the Council and approval by the Secretary of State was supported by the Council. In response to a query from **George Lambrick of CBA** in relation to the Soils Management Plan, Mr Taylor QC confirmed that this would be subject to the Secretary of State's approval. Mr Taylor QC also noted that it would dovetail with the DAMS, which would also be subject to the approval of the Secretary of State (by way of being a certified document under the DCO). Mr Taylor QC further confirmed that all plans or management strategies produced would need to be consistent with each other and the terms of the DAMS.
ii. Discussion on approval of the Construction Environmental Management Plan (CEMP) (MW-G5) and Handover Environmental Management Plan (HEMP) (MW-G11), including the Cultural Heritage Asset Management Plans (Cultural Heritage Asset Management Plans (CHAMPS) – Draft Detailed Archaeological Mitigation Strategy (DAMS), para 5.1.21).	**Reuben Taylor QC, on behalf of Highways England**, noted that as a result of the amendment to the DCO and OEMP referred to above, the CEMP would also be subject to Secretary of State approval. Mr Taylor QC explained that these amendments have knock on impacts in respect of the how the HEMP will be treated. As per the OEMP, MW-G11, the HEMP shall be based on the CEMP and the LEMP and the HEMP must then be implemented by the body responsible for the long-term management of the operational Scheme. Under the proposed mechanism to be adopted for approvals, the HEMP will need to be based on a CEMP and LEMP which have been independently approved by the Secretary of State and are therefore not based on documents approved internally by Highways England; there is therefore a significant level of independent oversight of the HEMP and a separate approval mechanism is not necessary. Mr Taylor QC explained that regarding the CHAMPS, there is a passing reference to these in the DAMS and Highways England is currently reviewing whether the DAMS needs to refer to the CHAMPS at all. The CHAMPS is an internal Highways England reporting document, prepared in order for Highways England to fulfil its obligations to care for the Government's cultural heritage estate. They are an internal Government statement of the state of the asset, and do not set out any management responsibility going forward. The CHAMPS are not documents that would normally (and have never, as far as Highways England is aware) be the subject of external approval, and would not assist with the mitigation of the Scheme. **Post hearing note**: Reference to the CHAMPS has been removed from the DAMS submitted at Deadline 8. In response to comments made by **Kate Fielden of Stonehenge Alliance** relating to the opportunity to view documents (required to be produced in accordance with the OEMP) prior to the end of the Examination, Mr Taylor QC explained that the OEMP provided a mechanism for the consultation of such plans as part of their preparation (MW-G5 with respect to the

	CEMP and MW-G7 with respect to the management plans). The consultation would be with statutory consultees: Wiltshire Council, the Environment Agency, Historic England and Natural England. Mr Taylor QC explained that those plans are to be produced by the contractor and are subject to detailed design of the Scheme, which is why the mechanisms for their preparation are set out now, as the plans are not available at this stage of the Application (which reflects the standard approach in DCOs).

4.2. Harm to the Outstanding Universal Value (OUV)

Agenda Item	Highways England response
i. The Ecological Clerk of Works (CoW) is in the Contractor's team. However the Archaeological CoW is in Highways England team. Why the difference?	**Chris Moore, on behalf of Highways England**, explained that given the scope of the archaeological works required and the proposal to deliver the vast majority of these during the Preliminary Works stage, Highways England has opted in this instance to bring the Archaeological Clerk of Works (**AcoW**) post within its own on-site team, in order more closely to manage the delivery of the archaeological site works programme. Mr Moore explained that the advantage of this was continuity in terms of the engagement with the members of HMAG, given the roles to be undertaken by the AcoW (D7 DAMS paragraph 6.1.17) in relation to monitoring archaeological site works and facilitating access and monitoring arrangements. **Post hearing note:** As an unrelated point, the Examining Authority asked whether the minutes of HMAG meetings were available. These minutes are the responsibility of and are held by HMAG, and Highways England is therefore not in a position to provide them to the Examination. However, if the Examining Authority has specific concerns to consider, Highways England can liaise with HMAG in order to assist the Examination.

4.3. Miscellaneous

Agenda Item	Highways England response
i. Construction compounds (MW-G28): Location and design. Function, size and appearance of the concrete batching plants, and their relationship to the Site Travel Plan [correct as slurry treatment plant].	**The Examining Authority** noted that the reference in the agenda to the "Site Travel Plan" should have been to the "slurry treatment plant". In response to a query from the **Examining Authority** as to the purpose of the concrete batching plants, **Steve McQuade, on behalf of Highways England**, explained that the batching plants are for the production of concrete needed on site. Mr McQuade explained that there would be storage hoppers for aggregate and cement, and confirmed that the concrete "rings" for the tunnel would be cast on site. **The Examining Authority** asked how the size and appearance of the concrete batching plant compared with the slurry treatment plant. Mr McQuade explained that the concrete batching plant would be smaller than the slurry treatment plant. The slurry treatment plant has been assessed in the Environmental Statement as being up to a height of 20 metres and would

	be located, along with the concrete batching plant, at the western half of the main construction compound, as indicated on Figure 2.7 of the Environmental Statement [APP-061] and as specified in the OEMP, ME-G28. Mr McQuade explained that the reason for this location was that the plant would be located further from the WHS and beyond a well-established hedgerow, that would be retained, and where the topography is falling away. MW-CH4 secures this, providing for the location of slurry treatment plant and batching plant, requiring it to be located to the west of the existing tall hedgerow.
ii. Approval of colours of buildings and hoarding	**Steve McQuade, on behalf of Highways England,** explained that the contractor will be required to provide in their CEMP general design measures (MW-G28 in OEMP), which include: (a) all buildings within compounds shall be in a suitable colour to aid in their integration within the landscape; and (b) hoarding installed around the perimeter of the compounds shall be in a suitable colour, to aid in its integration within the landscape. Mr McQuade also noted that the CEMP would be subject to SoS approval, and that the general consultation provisions on the CEMP secured by MW-G5 would also cover the above details in relation to colours of hoardings and buildings.
iii. Site Lighting (MW-G30): why no management plan under MW-G7? Approval? Environmental Statement Chapter 7, section 7.8, Table 7.4 is silent on site lighting.	**Steve McQuade, on behalf of Highways England,** explained that site lighting will be addressed within the CEMP, and is covered by the specific OEMP of PW-G6 (preliminary works general site lighting) MW-G29 (main works general site lighting), MW-BIO4 (lighting at important ecological sites), PW-BIO7 (bat roosts), PW-CH1 (heritage management plan), MW-CH1 (heritage management plan), Mr McQuade explained that it is therefore not considered that a standalone management plan is required as an additional element to the CEMP.
iv. Ground Movement Monitoring Strategy (MW-CH8, cf: DAMS, para 5.2.7). Has an agreed specification been established for acceptable levels of vibration and settlement? How should monitoring and remediation, during and post construction, be secured?	**Reuben Taylor QC, on behalf of Highways England**, confirmed that the submissions made by parties (Historic England, Stonehenge Alliance, ICOMOS UK) in relation to the appropriate method for monitoring settlement and impacts on archaeology indicated agreement in terms of there being no standard criteria for protecting heritage assets from settlement or vibration, due to the unique and varying sensitivity of such assets. Mr Taylor QC explained that the Ground Movement Monitoring Strategy will require Secretary of State approval, and will need to address the appropriate mitigation of movement and vibration of assets that are potentially affected. The strategy would be prepared and approved in a particular context, which is the requirement that in any event, best practicable means are used to minimise noise and vibration across the Scheme (OEMP PW-NOI1, MW-NOI1). The Secretary of State can therefore assume best practicable means in their consideration of the Ground Movement Monitoring Strategy.

	Mr Taylor QC explained that there are good reasons to not establish precise levels of vibration for the Scheme at this stage, not least given the assessment undertaken to date has adopted a conservative approach and is therefore extremely robust, and it has not identified likely significant vibration effects on heritage assets. The Applicant has explained points in relation to the sensitivity of the archaeological receptors and the nature of the archaeology and therefore how it would be affected by vibration and ground movement, at Issue Specific Hearing 5 (and recorded in the Applicant's written summary of oral submission from that hearing [REP4-033] in relation to Agenda Item 6(iii)). Mr Taylor QC submitted that the measures in place in the OEMP and the Ground Movement Monitoring Strategy (requiring Secretary of State approval) are appropriate and represent the correct approach to mitigate any potential risk of harm to heritage assets. In response to submissions by **George Lambrick, CBA**, querying paragraph 5.2.9 of the DAMS which requires "The monitoring requirements will be scoped to minimise the number of installations required", Mr Taylor QC explained that the monitoring done would have to comply with the requirements for best practicable means. The DAMS requirement is not inconsistent with the best practicable means requirement in the OEMP. Responding to submissions from other parties in relation to the nature of the geology, Mr Taylor QC referred to earlier documents where these points had been addressed by the Applicant: Applicant's written summary of oral submission from that hearing [REP4-033] in relation to Agenda Item 6(iii), and the Applicant's response to second written questions NS.2.8 [REP6-031], Fg 2.40 and Fg 2.51 [REP6-028]. In response to questions from the Examining Authority about the process to ensure that the assessment goes through due process, Mr Taylor QC explained that the process would be set out as part of the Noise and Vibration Management Plan and the Ground Movement Monitoring Strategy, both of which would be approved by the Secretary of State, and the Heritage Management Plan would be approved by Wiltshire Council. Mr Taylor QC explained that there would need to be consistency between all three plans, and that the preparation of the plans is managed by the contractor to ensure they all align. The same stakeholders are involved with respect to the preparation of each of the plans / strategies. Mr Taylor QC noted that once agreement is reached, actually expressing the process in the plans / strategies and ensuring a consistent approach should not be an overly onerous task. **Post hearing note:** Susan Denyer of ICOMOS UK raised queries in relation to where monitoring points would be and what they would determine. The Applicant undertook to respond to this point in writing. <u>Vibration Monitoring</u> Vibration monitoring locations will be contained within the Noise and Vibration Management Plan prepared by the main works contractor (OEMP, MW-NOI3, d). At this stage, before detailed design is completed, a commitment has been made to vibration monitoring at the Stonehenge monument when the tunnel boring machine is within 250m of the monument (MW-NOI6), due to the level of interest in the Stones. MW-NOI6 also includes a commitment to monitor vibration at Stonehenge

	Cottages when the tunnel boring machine is within 250m of the cottages, due to the potential for annoyance impacts. Although the Stonehenge Visitor Centre is remote from any construction works, based on a request from the English Heritage Trust, vibration monitoring at the Visitor Centre has also been agreed (MW-NOI6). The details of the monitoring at the Visitor Centre will be determined in consultation with the English Heritage Trust and set out in the Noise and Vibration Management Plan. Additional vibration monitoring locations at potentially sensitive heritage assets, such as barrows, will be determined on the basis of the further analysis required by MW-NOI5 to identify, in consultation with HMAG, any potentially vibration sensitive cultural heritage assets based on the sensitivity of the assets and proximity to tunnelling works (MW-NOI6). Such assets are also required to be identified by the Ground Movement Monitoring Strategy (MW-G7 and MW-CH8 of the OEMP). Whilst Highways England will continue to discuss with key stakeholders the issue of the methodology for measuring vibration during detailed design, it does not consider that it is necessary or appropriate to finalise this at this stage. The precise details of the vibration monitoring methodology will be set out in the Noise and Vibration Management Plan required by MW-NOI3. MW-NOI6 provides that the monitoring proposals will be included within the Noise and Vibration Management Plan. MW-G7 of the OEMP requires various management plans, including the Noise and Vibration Management Plan to be prepared in consultation with Wiltshire Council, the Environment Agency, Historic England and Natural England on those aspects that are relevant to their functions. As such, key stakeholders will feed into the process of determining the final vibration monitoring regime, including in relation to archaeology. The Noise and Vibration Management Plan will set out specific details of the vibration monitoring methodology in terms of the choice of transducers, method of coupling, measurement locations, measurement durations, etc., in accordance with the requirements of the relevant British Standards (BS 7385: 1993, BS ISO 4866:2010, and BS 5228: 2009+A1: 2014 as referenced in MW-NOI5. As agreed with Historic England, Stonehenge Alliance and ICOMOS UK there is no standard threshold for construction vibration levels significantly affecting archaeological earthworks, such as burial mounds, and buried assets, due to the unique and varying sensitivity of such assets. Once the detailed design is finalised suitable screening criteria will be determined by the main works contractor, in consultation with HMAG, based on the sensitivity of the assets along the route of the tunnel. The criteria will consider the approach taken on other major infrastructure projects, such as Crossrail, and the building damage guidance in relevant standards including BS 7385-2: 1993, BS ISO 4866:2010, and BS 5228: 2009+A1: 2014, as required by MW-NOI5, including the categorisation of the sensitivity of building structures to vibration provided in BS ISO 4866:2010 which identifies the most sensitive structures (Category 8 in Table B.1 of the standard) as ‘ruins and near-ruins and other buildings, all in a delicate state’. Though as noted in BS7385-2:1993 ‘structures below ground are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition’. This is due to buried structures, or artefacts, being supported by the surrounding consolidated soil matrix, rather than being free to move in the open air. The barrows are consolidated earthworks which have settled to their present state over 5000 years and are therefore unlikely to contain any voids. Any buried archaeological assets are below ground and therefore are surrounded by a consolidated soil matrix.

	Ground Movement Monitoring The plan for Ground Movement monitoring locations will be contained within the Ground Movement Monitoring Strategy (GMMS) prepared by the main works contractor (MW -G7 and MW-CH8). The GMMS and location of monitoring points will be prepared in consultation with the members of HMAG and be subject to Secretary of State Approval. As such, key stakeholders will feed into the process of determining the final monitoring regime including the location of monitoring points which are likely to be associated with the Scheduled Monuments in closest proximity to the tunnel works and as deemed appropriate to inform the risk management of the works e.g. at cross-passage locations. The main works contractor will design the GMMS in accordance with best practice including: British Tunnelling Society: Monitoring Underground Construction, A best practice guide; and ITAtech Guidelines on Monitoring Frequencies in Urban Tunnelling: ITAtech Report No.3-V2 May 2015. The contractor will implement proactive monitoring across the site during the tunnel works and, in accordance with best practice, continue until movement ceases or until the change due to the works is indistinguishable from baseline readings. As discussed at ISH2 Cultural Heritage and referenced in the written summary of the oral hearing item 6iii [REP4-030], monitoring will be implemented at regular spacing along the tunnel (most likely coincidental with cross-passage locations and faults through Stonehenge Bottom) with arrays provided perpendicular to the tunnel to fully incorporate the zone of tunnelling as defined by the 1mm settlement contour. Similar to provisions discussed under Vibration Monitoring (above), as agreed with Historic England, Stonehenge Alliance and ICOMOS UK there is no standard threshold for tunnelling induced ground movements affecting archaeological earthworks such as burial mounds and buried assets due to the unique and varying sensitivity of such assets. And in a similar manner, screening criteria will be determined by the contractor, in consultation with HMAG, based on the sensitivity of the assets along the route of the tunnel. For the purpose of monitoring a series of trigger levels will be established as informed by the assessment of the maximum settlement that could occur without having an adverse effect on the archaeological features. This trigger level monitoring approach will help to determine the development of ground movement and when there would be a need for intervention by way of ground stabilisation. Mr Taylor QC commented, in response to a concern raised by the Stonehenge Alliance about the danger of a collapse up to the ground surface, that Highways England does not share Stonehenge Alliance's view as to the risks of tunnelling through the geology that is present. Mr Taylor QC confirmed that the Examining Authority already has the Applicant's submissions in this respect, and that position has not changed. See Applicant's written summary of oral submission from that hearing [REP4-033] in relation to Agenda Item 6(iii).

	Post hearing note: The Applicant has further confirmed in response to written questions Fg. 1.5 [REP2-031] and Fg 2,51 [REP6-028] that in developing the preliminary design it has followed best practice as embodied in Association of British Insurers/British Tunnelling Society Joint Code of Practice for the Risk Management of Tunnel Works (ACOP) to: i. Undertake hazard identification and the management of risk to ensure their reduction to a level 'as low as reasonably practicable' as an integral consideration in the design, procurement and construction of the tunnel works. ii. Promote and secure best practice for the minimisation and management of risk as part of the Insurance of the works. iii. Undertaken suitable and sufficient site investigation phased appropriately to the pertaining physical and geological environments. In response to a comment by Colin Shell about what happens if acceptable levels are exceeded and the procedures for managing the situation, **Marie Ayliffe, on behalf of Highways England**, with respect to ground movement, directed the Examining Authority to the Applicant's response to second written question CH.2.9 (ii) [REP6-022]. Ms Ayliffe noted that the Applicant had explained previously how movement would be managed (see for example the written summary of the Applicant's oral submissions made at Issue Specific Hearing 2 [REP4-030], with respect to Agenda Item 7 (iii) under the heading "DAMS paragraph 4.2.6"), noting that a suite of measures could be employed if required. Ms Ayliffe explained that such measures could include grouting ahead of the main tunnel boring machine (**TBM**) which is a standard means of ground stabilisation, and toolbox measures that would automatically be implemented if ground movement was approaching a level deemed to be unacceptable. Ms Ayliffe confirmed that the choice of techniques will be developed by the contractor, informed by site specific investigation, and that the monitoring would be managed by the Ground Movement Monitoring Strategy. **Post hearing note:** The toolbox measures referred to by Ms Ayliffe could include grouting from the main tunnel prior to construction of cross-passages in conjunction with the use of spiles to support the ground being excavated in a staged manner that controls the rate at which settlement develops to reduce the strain in the ground. This technique can be demonstrated by reference to Crossrail C310 at ISH10 Flood Risk, Groundwater Protection, Geology and Land Contamination under item 6.i Tunnelling. On this occasion fissure grouting was undertaken from the main tunnel in conjunction with the use of spiles above the cross-passage and staged excavation (Crown, Bench/Invert) of the grouted ground prior to the installation of a Sprayed Concrete Lining to support the chalk and limit excavation induced ground settlement. With regard to vibration mitigation, the decision to implement a bored tunnel rather than a cut and cover tunnel was a deliberate design decision taken in order to preserve surface archaeology and avoid damage and disturbance as far as possible to archaeological sites, including those that contribute to the Outstanding Universal Value of the World Heritage Site. There is also mitigation embodied within the selection of the tunnel boring machine with the use of a closed-face TBM for the

	main tunnel construction to control excavation induced ground movement and vibration (OEMP, D-CH32). In addition, the contractor is under an obligation to adopt best practicable means (BPM) to minimise noise and vibration from the works (PW-NOI1 and MW-NOI1). As part of Ground Movement Monitoring Strategy (MW-CH8), and in accordance with MW-NOI5, the contractor shall develop contingencies using a suite of toolbox items from further investigation, assessment and monitoring during construction to identify measures to ensure the protection of heritage assets. This could range from simply slowing down the TBM to instigating ground stabilisation measures including grouting. MW-NOI5 requires any actions to control or mitigate impacts to be agreed between the main works contractor, the operator of the equipment and The Authority as appropriate, in consultation with the members of HMAG. Mr Lambrick of CBA asserted that 3D modelling should have been carried out. Mr Taylor QC explained that the application documents set out a detailed appraisal of the likely significant effects of the Scheme as far as it relates to ground settlement. This assessment included the application of the standard assessment approach, that has been used in every tunnelling project requiring consent. Mr Taylor QC clarified (in response to comments from Mr Lambrick) that the purpose of the monitoring proposed in the Ground Movement Monitoring Strategy was not to verify the computer modelling, as it is extremely robust. The monitoring is to ensure that much lower levels of settlement are generated by the Scheme. Mr Taylor QC further explained that there has been considerable research in terms of computer modelling being verified by monitoring, for example, Cross Rail, where the computer modelling predicted 10mm of settlement and the monitoring showed it was actually 1mm. Mr Taylor QC confirmed that the standard required by the best practice approach had been applied. Ms Ayliffe explained that it is not standard practice to have 3D geology models at this stage of a tunnelling project. The tunnelling contractor will not be relying on a 3D geology model; they will be relying on what is happening in the ground on the basis of the location-specific ground investigation particularly where they break out from the protection of the TBM tunnel primary lining at cross-passage locations. Ms Ayliffe further explained that a 3D geology model was useful in complex situations where other infrastructure was present and there was complex geology, however, such models have not been used on similar projects to the Scheme to the level of detail suggested. Ms Ayliffe confirmed that the approach for the Scheme has been to apply best practice, which has involved applying 2D modelling to a 3D environment. Ms Ayliffe noted that the assessment that had been undertaken was particularly conservative. **Post hearing note:** This assessment included the application of the standard conservative Greenfield assessment at 100m centres along the alignment as part of a staged approach to understanding the development of tunnelling-induced ground settlement, that has been used in every tunnelling project requiring consent; interpolation between these points is used as standard to apply the 2D results into 3D predictions of movement. The standard Greenfield assessment was supplemented by 2D Finite Element Analysis at 200m centres along the alignment, again interpolated into 3D predictions of movement, allowing more accurate modelling of the actual rock parameters determined from the Ground Investigation.

	Mr Taylor QC noted that the current requirement of the OEMP (MW-CH8) had been drafted to allow a flexible framework in order to allow for the flexibility of the approach of the contract. In any event, in response to a request from the Examining Authority, Mr Taylor QC agreed that the Applicant would consider whether more specificity was needed in relation to item MW-CH8 of the OEMP, to set out how monitoring would be achieved, implemented, scoped, and how actions arising from the monitoring would be secured. **Post hearing note:** Updates have been made to item MW-CH8 submitted at Deadline 8 in this regard. Highways England's view is that no Requirement is justified, since the provisions of the OEMP and the CEMP are themselves secured by Requirement 4.
a) Through the OEMP? : ***i. Through the Noise and Vibration Management Plan, Ground Movement Monitoring Strategy, or Heritage Management Plan (HMP)? How would the documents correlate and who would be responsible for particular aspects?*** ***ii. Wording regarding vibration/ settlement level and quality monitoring, reporting programme, trigger levels, action plans for mitigation/ remediation.*** ***iii. Appropriate reporting criteria: Should Wiltshire Council or Historic England's role be expanded beyond approval of SSWSIs, Method Statements and the HMP, and consultation on Noise and Vibration/ Ground Movement Monitoring?*** ***b) Through an additional Requirement? :***	These Agenda Items were touched upon as part of the discussion in relation to Agenda Item 4.3 (iv).

i. Appropriate wording, including consultation and approval bodies. ***ii. Approval of the details before tunnelling works commence.***	

4.4. Design

Agenda Item	Highways England response
i. Cutting profile (D-CH5): Notes that the grassed slopes either side of the cutting are to be approx. 2.5m wide, and approx. 1 in 2 gradient. They will therefore be approx. 1.25m high. They appear of much greater width, some 6 to 10m, in the Environmental Masterplan Figs 2.5P-S (drawings scale?), and the Structures Drawings (Sheet 7/13).	**Graham Martin, on behalf of Highways England**, displayed Figure 2.5 S on the screen, and explained that the grassed slopes either side of the cutting are approximately 2.5 metres deep with a 1 in 2 gradient and therefore approximately 5.0 metres wide as shown on Figure 2.5 S of the Environmental Masterplan and Typical Section and CH6900 on Sheet 8 of 12 of the Engineering Sections Drawings. The horizontal distance is about 6 metres. Mr Martin confirmed that the wording in D-CH5 of the OEMP would be amended to make clear the 2.5m relates to depth not width. **Post hearing note:** Changes have been made to the OEMP at Deadline 8 in this regard. **Post hearing note:** The Examining Authority asked for confirmation of the scale on the Environmental Masterplan. The Applicant can confirm that whilst Environmental Masterplan gives the scale as 1:500 at A1, it should be 1:500 at A3.
ii. Highway boundary fencing (D-CH25): Is to be no higher than ground level at the top of the cutting. Is this to be taken as 1.25m?	**Graham Martin, on behalf of Highways England**, explained that a fence of 1.25m would comply with OEMP requirement D-CH25. The fence at the western cutting could be any height as long as it complies with the requirement that "*the top of new highway boundary fencing within the western cutting shall be no higher than the ground level at the top of the cutting alongside which the fencing runs*". **Reuben Taylor QC, on behalf of Highways England**, also noted that OEMP requirement P-SL04 required "*Fence heights to generally be 1.2 meters high but must comply with standard minimum for adjacent land use e.g. higher for equestrians*". Various submissions were made by interested parties and the Examining Authority in relation to concerns about 1.2 metre fences in terms of safety and pedestrians endangering themselves.

	Mr Taylor QC noted that Highways England takes suicide risks very seriously, not just in relation to the Scheme, but in everything it does. He explained that the provisions with respect to fencing allow for an appropriate fence to be provided; there is a general provision for 1.2 metre fences, and scope for higher fences at the western cutting, up to 2.5 metres. The contractor will have to come forward with a final design that meets the constraints on design contained within the OEMP. Mr Taylor QC explained that 1.25 metres was the standard fence height for bridge parapets across the country. Mr Taylor QC confirmed that whilst matters of safety are addressed comprehensively by the design requirements of DMRB (which the contractor would be bound by), the Applicant would consider whether any further wording could be added to the OEMP. Mr Taylor QC also confirmed that the Applicant would consider a point raised by Colin Shell with respect to deer proof fencing. At Deadline 8, the OEMP has been updated to include a new Design Principle which states: 'The design of the Scheme shall be cognisant of public safety at the cuttings within the WHS'. No change has been made in respect of making an explicit commitment to installing deer proof fencing as a specific type of fencing, as it is not considered appropriate or necessary at the location of this Scheme given the measures already committed to in the OEMP respect of fencing and design of the cutting, including the need for liaison with landowners and the SCDG. In response to a query from the **Examining Authority** in relation to OEMP requirement D-CH5, Mr Martin confirmed that in terms of the retaining walls in the western approach cutting would be vertical or have a no greater incline than 1 in 10. The Applicant undertook to consider the wording in the OEMP requirement, as the Examining Authority indicated that “no shallower than” was confusing. These changes have been made to this item at Deadline 8.
iii. Design vision (Section 4.2): Discussion.	**Wiltshire Council, Historic England, the National Trust and the WHS Coordination Unit** referred to a workshop held earlier in the week by Highways England, to discuss the approach to design with stakeholders. **The Examining Authority** referred to paragraph 4.2.9 of the OEMP and the vision for the western section at sub-paragraph (a) (Reflect the downland and River Till character), noting that the aim should be to reduce the visual presence of the acoustic barrier at the River Till. Amendments have been made to the OEMP at Deadline 8 in this regard. With respect to sub-paragraph (b) (Respect the setting of Winterbourne Stoke), the Examining Authority suggested the word “reduce” should be strengthened. At Deadline 8, this text in the OEMP has been amended to 'minimise'. With respect to sub-paragraph 4.2.10 (b) (Due consideration of the objectives and policies of the WHS) the Examining Authority suggested that this vision “should acknowledge potential access within the WHS and its wider landscape”. This change has been made to the OEMP at Deadline 8. With respect to paragraph 4.2.11 (the vision for the eastern section), the Examining Authority noted that comments made in relation to paragraph 4.2.9(a) in relation to the River Till viaduct should also be considered in relation to the visibility of the noise barrier at Countess Flyover. Changes have been made to the OEMP at Deadline 8 in this regard.

	In response to assertions made by **Andrew Rhind-Tutt, Richard Hammond, on behalf of Highways England**, clarified that the visual material referred to by Mr Rhind-Tutt (in relation to the view from Amesbury Abbey) had been produced at an early stage of the Application for the Scheme, and there was subsequently various correspondence in this respect (this issue was also raised by Mr Rhind-Tutt at Issue Specific Hearing 2, and responded to by Highways England in the Applicant's written summary of oral submissions made with respect to Agenda Item 6 (vii) [REP4-030]). Mr Hammond explained that the Applicant was on site at Amesbury Abbey one month ago and took the opportunity to re-take photos from Blick Mead and Vespasian's Camp, as a double check of its assessment. Mr Hammond confirmed the Applicant's view that there is enough information to judge the Scheme by. Mr Hammond confirmed, in response to comments from the Examining Authority, that the earlier image was not incorrect when it was produced, however, it was produced at an earlier stage of the design process. The image was not part of the visual receptor group forming part of the environmental assessment and was therefore not reproduced. The Applicant agreed to re-produce the image based upon the photograph and surveying undertaken in July 2019 and the DCO scheme. This will be presented as a wireline image due to the existing vegetation being in leaf and submitted at Deadline 8.
iv. Design principles (Section 4.3): Discussion.	The **Examining Authority** suggested that with respect to design principle P-PWS06, it would be important to bear in mind that large scale symmetrical geometry should not be reflected onto the landscape forms. The Applicant acknowledges this, but considers that references in this principle (and others) to integrating with existing landforms and landscape character achieves this goal. The Examining Authority queried whether a living green wall could be considered for the acoustic screen at Countess Flyover, with respect to design principle P-PW-S07. **Post hearing note:** The use of a living green wall has currently not been considered due to uncertainty around the viability of a green wall in such close proximity to a major carriageway and the associated impacts from vehicle emissions and other highway associated pollutants. Additionally, a green wall would require regular long-term maintenance, increasing both the cost to operate / maintain the highway and the risk to workers who would be undertaking maintenance. The Principles section of the OEMP, submitted at Deadline 8 (refer to item P-PWS07), has been updated to include for the provision of planting on the acoustic screen at Countess Flyover, where practicable and safe to do so. The Examining Authority queried whether the OEMP requirement to not put mounding in the WHS which competes with archaeology mounds, conflicted with the green bridges and associated earthworks. **Post hearing note:** Green bridge 4 is the only green bridge within the WHS and it is not envisaged that there would be mounds associated with this structure. The intention of the restriction on mounds within the WHS relates to landscaping of structures which could be mistaken for heritage features e.g. barrows. Furthermore, item D-CH23 of the OEMP states that on green bridge four, the finished ground

	level shall replicate the existing ground levels, subject to the limits of deviation (being 0.25m upwards as per article 7 of the DCO). **Reuben Taylor QC, on behalf of Highways England**, noted that the design principles and commitments have evolved from a long process of engagement with Wiltshire Council, Historic England and other stakeholders, and that process continues.
v. Para 4.3.2 – Illustrated Examples of Key Design Elements, Annex A4: Discussion.	**The Examining Authority** referred to the Illustrated Examples of Key Design Elements [REP7-024], sub-paragraph 4.2.6 (d) and asked who would design the highways furniture and signage. **Steve McQuade, on behalf of Highways England**, confirmed that this would be the responsibility of the contractor, following the requirements of DMRB and in line with the OEMP requirements, design principles and commitments. The Examining Authority referred to the image of Green Bridge 4 in REP7-024, Key Principle B (P-PWS03 The surface finish of the western cutting retaining walls (within the WHS) to be in keeping with the character of the surrounding landscape). The Examining Authority asked the Applicant to consider if there would be some sort of integration of planting or a green living wall to reflect the character of the surrounding landscape. With regard to the concept of living green walls, please see the response to item iv. However, principle P-PWS01 of the OEMP submitted as Deadline 8 has been updated to include for the provision for the integration of planting within areas immediately adjacent to infrastructure to ensure a consistent level of 'greening'. This should be seen in the context of the other P-PWS principles, particularly P-PWS2, which calls for the palette and form of external scheme components to reflect the surrounding landscape character and create spaces which are natural in appearance. In terms of the Key Commitment at E (D-CH11 No road lighting of the Scheme during operation except under Green Bridge Four and Countess Roundabout and within the tunnel), the Examining Authority queried whether there would be light spillage / glow from the tunnel portals at night. Mr McQuade explained that lighting from the tunnel is controlled by OEMP PW-G6, however, this refers to site lighting during construction. As such, the reference should have been to D-CH9 which referred to tunnel portal lighting being designed to minimise light spill outside the portal's footprint. This has been expanded at Deadline 8 to add the words 'including design of lighting at the minimum luminosity that is necessary and safe'. Furthermore, paragraph 4.5.3 of the OEMP has been expanded such that SDCG will be consulted on the design of portal lighting. Mr McQuade confirmed, in response to a question from the Examining Authority, that Green Bridge 4 would only be lit during the day, as required by OEMP provision D-CH10. The Examining Authority asked about the "overhang" in the illustrated example of the western portal approach. **Graham Martin, on behalf of Highways England**, confirmed that this "overhang" was shown on the structures drawings submitted with the Application, and allows for the tunnel service buildings to be recessed, as shown on the portal structure on the engineering structure drawings ([APP-017] sheet 8 (section 2) for the west portal and Sheet 11 (section 2) for the east portal). The Applicant also notes item D-CH17 which commits the Applicant to a design where the central support wall of the tunnel canopy structures at each end of the tunnel shall be set back from the leading edge of the structure

	Mr McQuade confirmed, in response to a query from the Examining Authority, that the overhang has minimal additional noise benefits, and that the noise benefits are primarily from the road being in the deep cutting. Mr McQuade also confirmed that the finish of the retaining wall will impact on noise and that there is an OEMP requirement to deal with this (see OEMP D-NOI5). In terms of the grassed trench shown on the illustrated example of the western portal approach, in front of the fence, Mr Martin explained that this served a number of purposes; drainage, a walkway for maintenance, and it allows the fence on the concrete beam to be lower as its height is measured from the bottom of the trench. Mr Martin noted that the illustrated example is an interpretation of how the design principles and commitments could be interpreted. **Post hearing note**: **Paul Garwood** asked the full width of the cutting including walls. The width varies to suit the alignment of east and west bound carriageways as they separate from each other on tunnel approach. Remote from the tunnel the typical wall to wall width of the cutting would be 28.1m. At the western portal the indicative width measured between the face of the tunnel service building and opposite retaining wall would be 37.2m (this is the widest at the two emergency lay-bys). If measured between the limits the cantilevered overhangs on plan it would be 33.6m, widest at the portal entrance. For eastern portal the width from the service buildings to the opposite retaining wall would be 46.2m at the lay-bys, with maximum width between the overhangs being 40.6m at the portal entrance. The widths would vary between east and west due to the difference in length of the cut and cover sections. In addition a width of 6-10m would be required for the earthworks roll over in the top portion of each side of the cut. Responding to queries from **Andrew Rhind-Tutt** about where emergency vehicles would be positioned and how they would be lit, Mr Martin explained that there would not be any permanently positioned emergency vehicles, and emergency vehicles would attend as required, as for any other part of the highways network. Mr Martin explained that Highways England would have control over vehicles as it could close down lanes, in the case of an emergency. Mr Martin explained that there were laybys available should emergency vehicles have to wait outside the tunnel, and confirmed there would be no permanent lighting within the WHS including of the laybys. Mr Martin further explained that those laybys would only be lit if emergency services required lighting and brought their own temporary lighting. **Post hearing note:** Comments were made by **Kate Fielden of Stonehenge Alliance** in relation to the cutting being visible from the ex-A303 byway. The upper part of the cutting, i.e. the upper part of the retaining walls would be visible from parts of the ex-A303 which are broadly parallel with the length of cutting between Green Bridge no.4 and the western portal. This has been demonstrated by the Applicant through its submission of photomontage AS-082 which illustrates a part of the cutting around the western portal being visible, whilst the remainder of the cutting is not visible, being below the line of sight.

	Similarly, the Applicant has responded in REP7-035 that the design of the Scheme has taken account of the future users of the ex-A303 by siting the western portal in a low point within the landscape, so that the focus of the view will be across the landscape. The changes to the earthworks and upper part of the slope above the retaining walls will be integrated into the landscape by the proposed chalk grassland to maximise the concealment of the cutting, as indicated by AS-082. This visibility of the upper part of the cutting is both localised to a small part of the existing A303 and would form a small component of a new view for recreational users, as they cannot walk along the existing A303 presently. Within this new view, the focus will be across the landscape because of the cutting being sensitively sited and from locations such as adjacent to the Stones, the cutting will not be visible, as is demonstrated by REP7-035. Views of vehicles will also not be visible from most of the existing A303 when it is a restricted byway, as demonstrated by the Zone of Theoretical Visibility mapping presented in REP7-025, This mapping demonstrates a substantial reduction in the visibility of vehicles from across the wider landscape, with only a small part of the existing A303, broadly parallel with the western cutting, likely to have views of vehicles because it is in an elevated position. The design has taken account of this view through the proposed commitments in the OEMP (including P-PWS01 D-CH17, D-CH19, D-CH22, D-CH24, D-CH25) to integrate the western approach cutting so that it is sensitive to its place and demonstrates good aesthetics as far as possible as well as the LoD which allow for the 200m extension of the western portal from this elevated part of the existing A303. **George Lambrick of CBA** made submissions about the impact of smell from the tunnel portals and its impact on the setting ancient monuments. Mr Taylor QC referred the Examining Authority to appropriate controls already in place, in terms of OEMP requirement MW-AIR3 which requires a tunnel ventilation strategy. Mr Taylor QC confirmed that the impact of the Scheme has been assessed. Because this area has such good air quality, there is no risk of any of the European standards being exceeded. Mr Taylor QC further confirmed that the Scheme has no impact of significance in terms of air quality, and there are no receptors within the vicinity of the tunnel portals. **Post hearing note:** The Applicant has considered smell and scent, including traffic emissions, in relation to heritage assets and whether this aspect contributes to or detracts from the setting of heritage assets. The AG12 Winterbourne Stoke Crossroads Barrows [APP-195, page 204; APP-218, page 37] is located within approximately 20 metres of the A303/A360 due to the adjacent Longbarrow Roundabout. Whilst close to these routes air quality is still good in the area and this is demonstrated by air quality monitoring undertaken by Highways England. In particular this is shown by diffusion tube reference AMES_012 [APP-063, Table 5.1.1] which is located to the south of the Long Barrow Roundabout. This diffusion tube recorded an annual average concentration of 21.6 µg/m3, which is well within the annual average air quality objective of 40 µg/m3. Regarding the impacts of emissions from the operation of the Scheme, a discussion on emissions from the tunnel portals is presented in the ES Chapter 5 Air Quality [APP-043, paragraphs 5.9.45-5.9.54]. Additionally, the air quality effects of the

	Scheme around tunnel portals and approaches were considered within the response to written question AQ1.12 [REP2-023]. The response identified that air quality around the scheme approaches and tunnel portals is good and that significant air quality effects were not expected. This is also the case for the area around AG12 Winterbourne Stoke Crossroads Barrow, with sources of pollution associated with the A303 and A360 both moving further from the barrow than the existing situation (e.g. A303 currently within approximately 20m, with the Scheme approximately 130m). In relation to smells, road traffic is not a recognised source of odour, as the principal emissions from road vehicles are oxides of nitrogen and particulates which are not odorous. In summary the air quality effects associated with the Scheme are not significant and will not adversely affect the setting of asset groups or discrete or isolated assets that contribute to the OUV of the WHS.
vi. Design consultation (Section 4.5): Discussion.	**Wiltshire Council, Historic England and National Trust** commented on the progress of discussions with Highways England on section 4.5. The Applicant made no additional comment.
vii. Para 4.5.14 – Final Decision on Detailed Design: Why not the traditional arrangement, whereby highways and planning requirements each have to be separately met and then approved by the competent statutory authority?	**Reuben Taylor QC, on behalf of Highways England**, noted that the reference in the Agenda Item to "the traditional arrangements" was confusing, as in terms of 'detailed design', for Highways England DCOs (and consents under the Highways Act 1980), the 'traditional arrangement' alluded to does generally not apply. Ordinarily the Secretary of State would only be involved in questions of detailed design where there was a departure from the consenting "envelope" or parameters consented by the DCO. The "envelope" is influenced by approved documents such as the OEMP and the DAMS. NSIPs are projects of national significance that require to be approved and delivered without detailed design being subject to extensive further approvals. It is therefore not appropriate for consenting of detailed design by the Secretary of State. Mr Taylor QC explained that it was entirely appropriate for Highways England, as the Strategic Highways Company with the responsibility for operating the strategic road network and responsible for delivering the Scheme, to have the final decision on detailed design, using its expertise and knowledge as to what would be appropriate and operationally feasible in the context of the Scheme. Mr Taylor QC also noted that other stakeholders have not requested Secretary of State approval in this respect. **Richard Moules, on behalf of Wiltshire Council**, confirmed that Wiltshire Council is content with the proposed arrangement, and noted that the detailed design requirements will be reflected in the CEMP to be approved by the Secretary of State, and that this gave the Council sufficient comfort. **Patrick Robinson, on behalf of the National Trust**, noted that the National Trust was agreeable to the proposed approach in principle, subject to the appropriate consultation, as provided for by Section 4 of the OEMP, being undertaken.

viii. Selection of MW Contractor: How do design capabilities feature in the selection criteria? Past track record? Proposed engagement of design consultants? Candidates' submissions might include an illustrated account of how they intend to meet the design principles?	**David Bullock of Highways England** explained the procurement process for the MW contractor for the Scheme. Mr Bullock explained that Highways England undertake the procurement with great consideration in terms of detail. There are three stages to the procurement process: 1. The first stage is issuing an OJEU call for competition notice to the market. This stage requires interested contractor and design teams to complete a detailed selection questionnaire about their capabilities and experience of similar work and design. Mr Bullock confirmed that for a project of this nature, the pool of contractors who would meet the criteria for working on similar schemes is small, and 20-30 responses would be expected at stage 1. 2. The second stage involves narrowing the list of contractor and design teams to three, and those three undergo a 6 month period of competitive dialogue. This is a much more detailed phase of the procurement and is targeted to enable Highways England to sit down with the contractor and design teams to test scenarios, including design principles, commitments and vision. Mr Bullock stated that Highways England is confident that at the end of this stage it would be able to select a contractor and design team that is capable of undertaking the project and delivering quality of design. 3. The third stage is selecting the final candidate and awarding the contract, ensuring that Highways England has the best quality and value for money overall.

5. DAMS (DL7 version [REP7-019 and REP7-020])

5.1. Part 1 - DAMS

Agenda Item	Highways England response
i. Para 1.1.4 – Status of document. Discussion regarding agreement on, or approval of, the final version of the DAMS.	**Reuben Taylor, on behalf of Highways England**, confirmed the Applicant's intention that the DAMS would be approved by the Secretary of State as a certified document.
ii. Section 4 – Archaeological Research Agenda. Discussion.	Submissions were made by **Paul Garwood of the Consortium of Archaeologists and Blick Mead Project Team** and **George Lambrick of CBA**, with respect to the Archaeological Research Agenda (ARA). **Reuben Taylor QC, on behalf of Highways England**, explained that the purpose of the ARA (set out in section 4 of the DAMS) is to guide the development of SSWSIs based on the archaeological mitigation strategy set out in Part 1 of the document and the OWSI (Part 2 of the document). It is not an attempt to define a research strategy covering all aspects of research focus, and archaeological evidence in the WHS and its environs. This reflects the purpose of the DAMS, which is to

	identify the measures required to preserve or record archaeological remains unavoidably impacted by the Scheme. The DAMS considers the different impacts, relevant mitigation principles and methods through the full archaeological process both on and off site. The DAMS includes a detailed consideration of these aspects and the relevant research themes and questions in respect of each of the 64 mitigation areas identified in Part 4 of the document. Mr Taylor QC submitted that the DAMS provides a comprehensive strategy for the mitigation of impacts on archaeological remains and is fit for purpose as the basis for development of Heritage Management Plans, Method Statements and SSWSIs. **Post-hearing note:** The Archaeological Research Agenda (ARA) set out at section 4 of the DAMS considers the archaeological evidence identified during the evaluation programme and known from other surveys in the area, against the themes and research questions set out in relevant published research frameworks. These include the Stonehenge and Avebury Archaeological Research Framework (SAARF), the South West Archaeological Research Framework (SWARF), and selected period-specific research agendas. As part of the DAMS, the ARA has been developed in consultation with HMAG and the Scientific Committee, who were invited to contribute research themes and questions. The Applicant has carefully scrutinised the submissions made by the Consortium of Archaeologists and the Council for British Archaeology. Dr Garwood for the Consortium of Archaeologists suggests that the DAMS is flawed in not proposing mitigation of landscape impacts: this both overlooks the purpose and role of the DAMS in mitigating the impact of the Scheme, as outlined by Mr Taylor QC, and fails to recognise that the Scheme design incorporates design mitigation to avoid and minimise these impacts. Dr Garwood goes on to criticise the DAMS for its use of published research frameworks. The Applicant submits that the purpose of these published frameworks is to guide the development of project-based research agendas: this is what the DAMS seeks to do. Further, the use of published frameworks to guide the ARA has considered period- as well as site-based agendas and frameworks to assist in identifying the potential for site-specific research questions to be formulated in the SSWSIs: the ARA is intended to inform the mitigation process, not to prescribe or constrain research. Mr Lambrick for the Council for British Archaeology suggests that the research questions identified in the ARA are too narrow. The Applicant submits that the ARA is based on the evaluation evidence and that this evidence has been correctly analysed and used in developing not only the ARA but also the mitigation strategies and approaches set out in the DAMS.
iii. Para 5.1.18 – Unexpected discoveries during the construction process. Do these procedures also apply to the Preliminary Works?	**Chris Moore, on behalf of Highways England**, explained that the procedures for unexpected discoveries are intended to apply during both Preliminary and Main Works (PW, MW) stages, as stated at paragraph 6.1.18 of the DAMS. It is intended that paragraph 5.1.18 should apply to the Preliminary Works also (and this amendment has been made for the DAMS submitted at Deadline 8). Mr Moore explained that if there are unexpected finds during the PW or MW stages, a site consultation meeting will be convened between the Archaeological Contractor, Wiltshire Council and Historic England and, for sites within the WHS, HMAG, and the Technical Partner Archaeologist to consider the significance of the find. Depending on the outcome of the meeting, an addendum or new SSWSI will be prepared, to be approved by Wiltshire Council (in consultation with Historic England, to the extent the works the subject of the approval would ordinarily trigger the need for scheduled monument consent) – i.e. the SSWSI process is followed.

	Responding to submissions from **George Lambrick of CBA** that this paragraph of the DAMS had to be read in connection with paragraph 6.1.20 on Interruptions and Delays, Mr Moore explained that the process for interruptions and delays was distinct from the unexpected finds process, as the former requires a quick response on site. In response to comments from Mr Lambrick about delays or unexpected finds affecting the delivery programme, Mr Moore explained that the Scheme aims to deliver 90% of the archaeological works during the PW stage, and as a result it is expected that archaeology would be removed before the MW stage commences. Highways England is therefore content that the risk in terms of programme delay has been managed in the way the works are being contracted. **Reuben Taylor QC, on behalf of Highways England**, made clear that the suggestion put by Paul Gossage that Highways England or its contractors would hide or ignore any archaeological finds was strongly rejected by Highways England. Mr Taylor QC submitted that the time and effort in preparing the DAMS demonstrated very clearly that it was not a sham exercise.
iv. Para 5.2.10 – Tunnel Protection Zones. Discussion	**Chris Moore, on behalf of Highways England**, explained that the tunnel protection zones have been introduced into the DAMS in order to highlight that these zones apply, and so that there's a mechanism by which those wanting to undertake archaeological works in future are made aware of the restrictions. Mr Moore explained that the DAMS was not the mechanism by which the restrictions themselves are secured; that is by restrictive covenants on the land. **Historic England and the National Trust** made submissions about the detail of the restrictions themselves and whether the figures showing the tunnel protection zones should be included within the DAMS. **Post hearing note:** As noted by Mr Moore at the issue specific hearing, the DAMS is not the mechanism by which the restrictions in the tunnel protection zones are secured; it is simply the means of noting the obligations of National Trust and Wiltshire Council to ensure those wanting to do works in those zones in future are made aware of the restrictions. The detail of the restrictions themselves, including the accompanying plans, will be included in and secured by the restrictive covenants. Therefore, whilst the DAMS cannot be inconsistent with the detail of the restrictive covenant, the intention is not that the DAMS would be relied upon in order to understand the detail of the restrictions, which is appropriate given its function relates to the archaeological mitigation works for the Scheme, rather than future archaeological works unconnected with the Scheme. The Applicant does therefore not propose to add further detail about the restrictions nor to include the plans in the DAMS. **Reuben Taylor QC, on behalf of Highways England**, clarified, in response to a comment from Historic England, that entering into a restrictive covenant cannot or does not remove the need for the statutory processes for scheduled monument consent to apply.

v. Para 5.2.18 – Soils handling strategy. Discussion	**George Lambrick of CBA** made submissions with respect to the DEFRA code of practice and how it sits alongside the requirements for preservation in situ. Mr Lambrick made submissions about paragraph 5.1.2 of the DAMS and appeared to suggest the effect of this paragraph was that less preservation in situ could be undertaken as a result of the need to also comply with the DEFRA code. **Reuben Taylor QC, on behalf of Highways England**, explained that the words in paragraph 5.1.2 are of a general introductory tone, introducing the detail in the remainder of the section. The words need to be read in that context, and in the context of paragraph 5.1.1. Mr Taylor QC confirmed that where preservation in situ is achievable, it is proposed to be done, and noted that discussions had been carried out in relation to the detail of where preservation in situ would be undertaken. **Post hearing note:** Paragraphs 5.1.1 and 5.1.2 are amended to clarify this in the final DAMS to be submitted at D8: "5.1.1: […] In accordance with DMRB, priority will be given to the preservation of archaeological remains. Where avoidance of remains is not possible, measures will include protection of remains within working areas, preservation of archaeological remains that are required to be covered over temporarily (e.g. in compound areas or beneath temporary roads), and preservation of archaeological remains that will be permanently covered beneath shallow fill. 5.1.2 In respect of archaeological remains within the footprint of the Scheme, a comprehensive programme of archaeological mitigation fieldwork and recording will be implemented […]." Mr Taylor QC undertook to provide the DEFRA code of practice (DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009)) to the Examination, and this is attached as **Appendix A** to this summary. Mr Taylor QC explained that the Code "*contains guidance of interest to those involved at all stages of construction projects, from the developer, designer, contractor, sub-contractor (earthworks, landscape) and regulator*" (paragraph 2), and paragraph 3 of the Code confirms that "*the Code itself is not legislatively binding*". Mr Taylor QC submitted that there is therefore a code to which regard has been had, but it is a code written to apply to the construction industry for the whole of England; it is not specifically designed to apply within (for example) a WHS. To that extent, plainly its provisions are relevant and of interest and should be taken into account, but in this context, what is proposed in the DAMS is a very detailed and specific framework to be applied to a very specific heritage context. Mr Taylor QC confirmed that the Code is not a law that must be applied. Mr Taylor QC agreed with the **Examining Authority's** remark that Highways England does not expect the DEFRA Code to override the detailed considerations in the DAMS. **Post hearing note:** The OEMP has been amended at Deadline 8 to provide clarity on this matter providing that the Applicant must have regard to the Code of Practice rather than 'following' it. The Examining Authority, responding to further submissions from Mr Lambrick, noted that it appears the SSWSIs are the prime director of how things occur, and that ought to override general codes of practice.

	Mr Lambrick made further submissions in relation to compounds, haul roads and other temporary works, and whether sites identified as preservation in situ would end up being archaeologically recorded instead because of soil requirements. In response, Mr Taylor QC referred to OEMP provisions PW-GEO3 and MW-GEO3, which require the PW and MW contractors to produce a detailed Soils Management Strategy (SMS). The SMS will be formed of two parts (Item MW-GEO7 within Table 3.2b of the OEMP): a Soil Resource Plan and a Soils Handling strategy. The Soil Resource Plan will confirm the soil types, the most appropriate re-use for the different types of soils and proposed methods for handling, storing and replacing soils on-site. The record of the existing soil resources in each land parcel forms part of the Preconstruction Soil Statements (refer to items PW-COM2 and MW-COM4 of the OEMP) and provides a specification for the restoration of land following the construction period. The Soils Handling Strategy will be developed with reference to BS3882:2015 Specification for Topsoil and the Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. This shall incorporate the soils handling measures outlined within the Detailed Archaeological Mitigation Strategy (DAMS), identify locations where archaeological in-situ preservation is required and consider areas to be returned to agricultural use. Mr Taylor QC explained that the Soils Handling Strategy will set out detailed requirements on a case by case basis. There is in essence a site specific approach to dealing with this issue, which takes into account the WHS status of the land, combined with aspects of sustainable soils usage. What Highways England is not doing is giving priority to a code, which is simply a code of generalised application; rather it is developing a bespoke response. **Post hearing note:** In response to a question from the Examining Authority, the Applicant confirms that in terms of method statements prepared as part of the Soils Management Strategy, the Method Statement setting out the method for mapping and placement of topsoil will be prepared by the MW Contractor, in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG, for approval by Wiltshire Council (in consultation with Historic England) (see DAMS, paragraph 5.2.19).
vi. Para 5.2.35 – Earthworks haul roads. In addition to the all-weather haul roads indicated in Fig 2.7. How is archaeology to be protected?	**Chris Moore, on behalf of Highways England**, explained that, as stated in paragraph 5.2.32 of the DAMS, wherever possible, construction plant will travel along the alignment of the Scheme using the footprint of the proposed embankments and cuttings. In these areas, the archaeological mitigation works as proposed in the DAMS will have been completed during the preliminary works stage, prior to the establishment of earthworks haul roads or temporary all-weather roads. Consequently, no archaeological protection will be required in these areas. Mr Moore indicated that two locations were identified that would require preservation in situ. These locations where haul roads are proposed outside the earthworks trace and will cross archaeological sites which require protection and preservation in situ are identified in the DAMS as sites 25.1 and 25.2, sections of the all-weather road between the Main Civils Compound and Green Bridge No.1, as discussed in paragraph 5.2.37. All other temporary all-weather roads will run within the chalk

	cutting (paragraph 5.2.37).

5.2. *Part 2 - Overarching Written Scheme of Investigation (WSI)*

Agenda Item	Highways England response
i. Para 6.1.13- Archaeological Project Team. Are the posts occupied by separate individuals, or may one person cover several posts?	**Chris Moore, on behalf of Highways England**, explained that, the Archaeological Project Team (APT) listed at 6.1.13 is intended to secure the provision of expert advice throughout the development of SSWSIs and the implementation of the archaeological works. A range of roles are identified, and the intention is that these roles should be filled by named specialists. There is no requirement that these roles should be filled by separate individuals, indeed it is likely that the APT will include individuals who can fill more than one role. Use of the term 'postholders' in paragraph 6.1.13 is not intended to preclude this possibility.
ii. Para 6.1.21 – Interruptions and Delays. Agreement should take place between the parties on cessation or resumption.	**Chris Moore, on behalf of Highways England**, explained that the provisions for management of decisions regarding interruptions and delays set out in paragraph 6.1.21 recognise the need for prompt decision-making to prevent potential damage to archaeological remains. Given the need for those timely decisions to be made on site, Highways England consider these should be made by the Archaeological Contractor and the Technical Partner's Archaeologist (TPA). The TPA will be represented on site by the Archaeological Clerk of Works, ensuring full awareness of the circumstances. Wiltshire Council, Historic England and HMAG will be kept fully informed through the monitoring provisions at Section 8.1. Mr Moore further explained that the SSWSI (to be approved by Wiltshire Council) also provides for the overall regulation of the works. Highways England considers that it would be impractical for decisions under paragraph 6.1.21 to be subject to approval by Wiltshire Council via the consultations and approvals processes set out in section 8.5 and 8.6 respectively. **Richard Moules, on behalf of Wiltshire Council**, submitted that the Council wanted the power to order the cessation and resumption of works. **Reuben Taylor QC, on behalf of Highways England**, sought clarification from Wiltshire Council whether it intended to have someone on site at all times, given the nature of the decisions to be taken under this paragraph of the DAMS. Mr Moules confirmed Wiltshire Council's expectation that the contractor would notify Wiltshire Council upon finding something. Mr Moules compared the powers sought as comparable to serving a stop notice. Mr Taylor QC noted that the situation envisaged by the DAMS in this case was very different from a stop notice. Mr Moore explained that this paragraph 6.1.21 of the DAMS would take effect in the case of delays and interruptions due to extreme and unexpected weather conditions, not unexpected finds; circumstances that would put at risk the mitigation, meaning the work would be suspended. Mr Moore explained that if ceasing work in response to conditions on site, that decision needs to be undertaken on site in a timely manner. Given the potential for rapid changes or rapid improvements, there is no reason why Highways England should not be able to cease and resume work as decided on site.

	Post hearing note: Paragraph 6.1.23 is amended in the DAMS submitted at D8 to elaborate on the circumstances in which an immediate decision on site is required: "6.1.23 Day-to-day decisions regarding site conditions will fall to the Archaeological Contractor, in consultation with the ACoW. Where extreme conditions arise requiring an immediate decision on site as to whether work should be suspended for a prolonged (more than 24 hours) period, the Archaeological Contractor will liaise directly with the ACoW and the PW or MW Contractor (as relevant). The TPA will be informed of which sites are affected and the reason(s) and likely duration of the interruption and delay, and whether any remedial actions are necessary or are planned (e.g. use of protective shelters or covers to protect exposed archaeological remains during episodes of wet weather, frost etc.). The TPA will inform Wiltshire Council and Historic England and, for sites within the WHS, HMAG, of the circumstances of any interruptions and delays. Resumption of work in such circumstances will be subject to consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG. Nothing in this clause is intended to prevent Wiltshire Council (in consultation with Historic England and for sites within the WHS, HMAG) making representations regarding cessation or resumption of work, through the monitoring provisions described in section 8 of the Strategy (below). Mr Taylor QC noted the difficulty if Highways England was required to obtain the approval of Wiltshire Council off site, based on conditions on site.

5.3. Preservation in Situ – Section 6.2

Agenda Item	Highways England response
i. Paras 6.2.4 to 6.2.6 - Preservation Beneath Fill. The method statement should take account of the different kinds of possible overload - heavy, dynamic load as well as static load (cf paras 5.3.16 to 5.3.19 – Protection beneath fill material and construction working areas).	**Reuben Taylor QC, on behalf of Highways England**, confirmed Highways England's agreement that the wording of the DAMS needs to be amended to acknowledge the need for the method statement to take into account dynamic loads as well as static loads. **Post hearing note:** Paragraph 6.2.6 is amended in the DAMS submitted at D8 to take account of dynamic loads. "6.2.6 The PW or MW Contractor (as relevant) will describe in a Method Statement the effects of compression and loading (whether dynamic or static) and site specific protective measures, including the extent of the area to be protected, the depth of fill required and the type of fill […]."

5.4. Preservation by record – sections 6.3 to 6.5

(including a 10 minute presentation by Professor Parker Pearson)

Agenda Item	Highways England response

i. Archaeological excavation and recording	
• ***Agreement required on a baseline percentage for plough zone and other sampling.*** • ***Para 6.3.15 – How would the mechanism of a reflexive approach operate? How are trigger points and proportions determined?*** • ***Para 6.3.22 – Should decisions regarding cleaning by hand be made by the Contractor or by others?*** • ***Para 6.3.44 to 6.3.48 – Changes to the sampling strategy would mean a revised SSWSI, subject to Wiltshire Council's approval.*** • ***Para 6.3.50 – Agreement required on the proportion of tree hollows excavated.*** • ***Para 6.3.77 – Treatment of human remains. Discussion.***	**Chris Moore, on behalf of Highways England**, explained that the D7 DAMS proposes at paragraphs 6.3.14 that a representative sample will be identified for further ploughzone sampling, in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG. In some areas, a sample of up to 100% of the artefact content of the ploughsoil may be necessary, combined with a systematic sample to capture background distributions and transitional areas. The strategy will adopt a reflexive approach such that the sample size may be increased locally in response to the results of the systematic sampling. Mr Moore, in response to a query from the **Examining Authority** as to how the reflexive approach would work, explained that a representative sample, identified through statistical analysis, would be recovered as the works are being undertaken, as part of an iterative approach to be applied on site in consultation with Wiltshire Council, Historic England and HMAG. There are therefore opportunities to increase the sample, and to further target areas where there is a low recovery, to ensure an accurate interpretation of an area. Mr Moore agreed with a comment from the Examining Authority that an iterative, developing approach was proposed. Mr Moore explained that this would be dealt with by SSWSIs and onsite monitoring meetings, provided by section 8 of the DAMS. The Examining Authority commented that this would be a continuous process which may require 100% sampling, based on the approach and with input from Wiltshire Council, Historic England and HMAG. Mr Moore confirmed that this was correct, and that whilst the sampling may end up at 100%, the intention was not that it start at that level. **Historic England and the National Trust** made submissions in relation to the ongoing work in terms of statistical analysis in order to identify a baseline percentage in the DAMS. There were also submissions from **Ms Hutton on behalf of the Consortium of Archaeologists and Blick Mead Project Team**, Historic England and the National Trust with respect to the industry approach to identifying a baseline percentage. Other interested parties also made submissions about the level of sampling they considered appropriate. To the extent items listed in this Agenda Item were not covered during the issue specific hearing, parties were invited to make written submissions on any specific points. **Post hearing note:** <u>Baseline percentage for plough zone and other sampling</u> The iterative or reflexive approach to sampling of the ploughsoil artefact content, with a sample selected on the basis of statistical analysis, has been developed in discussion with HMAG. The aim is to follow an intelligent approach, targeting the mitigation works in a way that is both appropriate and proportionate. This approach was endorsed at Issue Specific Hearing 2 by Dr Woodhouse for Historic England and Dr Snashall for the National Trust.

	The recovery of 100% of all ploughzone artefact material as suggested by the Consortium of Archaeologists and the Council for British Archaeology is neither reflexive nor intelligent in its approach. Both the National Trust and Wiltshire Council have disputed the assertion by Professor Parker Pearson that this has been a standard requirement in the WHS for a decade or more: rather, the requirements are set on a case by case basis. Indeed, the recent research work by Dr Garwood was not subject to this requirement. Highways England does not accept that 100% of all ploughzone artefact material should be recovered as a baseline 'sample': this proposition is neither reasonable nor practicable and potentially exposes the project to unquantifiable costs and delay. Highways England's position remains that a representative sample, identified through statistical analysis, should be recovered as part of an iterative approach to be applied on site in consultation with Wiltshire Council, Historic England and HMAG. This approach does not necessitate agreement of a baseline ploughzone artefact sample percentage in the DAMS: the appropriate baseline sample size, based on the results of the statistical analysis, having regard to the research questions to be developed from the ARA, will be identified in the SSWSIs to be developed in consultation with Wiltshire Council, Historic England and HMAG and approved by Wiltshire Council and Historic England. With regard to excavation sample sizes, the D7 DAMS considers these at paragraphs 6.3.35 – 6.3.51. These sections identify minimum sample sizes for different types of archaeological features and tree hollows. Within the WHS, the strategy provides for the 100% excavation of all archaeological features. In all areas, the sample excavation strategy would be applied as part of an iterative approach, in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG. It should be noted with regard to the emphasis placed by the Council for British Archaeology on the proportion NOT excavated, that sample excavation is the standard approach to the investigation and recording of archaeological remains, taking into account their date, nature and significance. The DAMS provides for this in the context of strategies for geoarchaeology, artefact recovery and other approaches that will combine to influence the overall sample size that is excavated. The reflexive strategy sets a minimum sample size but does not prescribe a maximum. It is misleading to suggest that the DAMS approach will lead to the loss of a majority of the archaeological remains without record: the approaches proposed have been developed in consultation with Wiltshire Council, Historic England and HMAG, and meet or exceed industry standards. The Council for British Archaeology take issue with the use of the term 'preservation by record'. This term is used in the DAMS as a convenient shorthand indicating the need for one or more forms of archaeological recording, in circumstance where archaeological remains cannot be preserved. In the DAMS, the term is applied to encompass Archaeological Excavation and Recording, Strip Map and Record, Archaeological Recording and Monitoring, Topographic Survey, etc. The Applicant acknowledges that the term is not used in current policy and guidance, but submits that the use of the term in the DAMS is clear and the archaeological mitigation approaches covered by the term represent current practice. <u>Para 6.3.15 – How would the mechanism of a reflexive approach operate? How are trigger points and proportions determined?</u>

	In terms of the reflexive approach, the sample excavation strategy would be applied in all areas as part of an iterative (reflexive) approach, responding to the form, extent and significance of archaeological remains revealed. The iterative or reflexive approach would be applied in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG. This consultation would take place through the mechanism of the on-site monitoring meetings as outlined in section 8.1 of the DAMS. Initially the minimum sample sizes would be implemented on site by the Archaeological Contractor in accordance with the approved SSWSI, this would be reviewed and agreed through the monitoring meetings. The reflexive process will allow the recovery of finds and samples for dating and assessment for their palaeoenvironmental and geoarchaeological potential. By its nature, the reflexive process does not rely on pre-determined trigger points or proportions; rather, it uses emerging evidence on site to inform the application of the strategies set out in section 6 of the DAMS to address the research questions posed in the SSWSIs. Para 6.3.22 – Should decisions regarding cleaning by hand be made by the Contractor or by others? In all areas, the sample excavation strategy would be applied as part of an iterative (reflexive) approach, responding to the form, extent and significance of archaeological remains revealed. This will include decisions regarding the extent of hand cleaning necessary to identify archaeological remains following machine stripping. The iterative or reflexive approach would be applied in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG, through the mechanism of the on-site monitoring meetings as outlined in section 8.1 of the DAMS. Initially, hand cleaning requirements identified in the approved SSWSI will be implemented by the Archaeological Contractor, these will be reviewed and agreed through the monitoring meetings. Para 6.3.44 to 6.3.48 – Changes to the sampling strategy would mean a revised SSWSI, subject to Wiltshire Council's approval. Paragraphs 6.3.44 to 6.3.48 of REP6-013 deal with the approach to excavation and recording of specific types of archaeological deposits, for which it is not relevant to specify a minimum sample size: excavation of these features or deposits will follow an iterative process to be applied in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG. This approach requires the agreement of the sample size through the mechanism of the on-site monitoring meetings as outlined in section 8.1 of the DAMS. Para 6.3.50 – Proportion of tree hollows excavated. The D7 DAMS proposes at paragraph 6.3.49 - 51 that all tree hollows or possible tree hollows will be mapped and a representative sample identified for excavation, in consultation with Wiltshire Council and Historic England and, for sites within the WHS, HMAG. A rationale for identifying a representative sample is proposed in paragraph 6.3.49. The strategy will adopt a reflexive approach such that the sample size may be revised in response to the results of the systematic sampling. This approach does not require agreement of a baseline tree hollow sample percentage in the DAMS. Para 6.3.77 – Treatment of human remains.

	The text regarding the DCO provisions for treatment of human remains is amended in the final DAMS submitted at D8 (paragraph 6.3.75): 6.3.75 If any human remains are encountered that need to be removed, this will be done in accordance with Article 16 of the DCO, which sets out provisions to be followed for the removal of human remains. The work will be undertaken by archaeological specialists, with the respect due to the treatment of human remains, in accordance with current good practice and archaeological standards and guidance. At the end of the project the intention is that human remains that are not required to be re-interred under the provisions of the DCO (and which have therefore been subject to a direction from the Secretary of State), will be integrated into the project archive and deposited at Salisbury Museum with the rest of the project archive (refer to section 10 of this DAMS and the indicative timeline at Appendix A.9). The Archaeological Contractor shall be responsible for liaising with Salisbury Museum at the initial project set-up stage to identify any specific requirements or policies of the Museum in respect of human remains, and will adhere to those requirements. In the interim, the Archaeological Contractor shall ensure that all human remains are stored safely, privately and decently by the Archaeological Contractor under the control of the APT human remains specialist.
ii. Strip, Map and Record	
• ***Para 6.4.4 – Agreement required on a baseline percentage for the proportion of features excavated.***	This item was not covered at the issue specific hearing, and parties were invited to make any specific submissions in writing. **Post hearing note:** Section 6.4 of the D7 DAMS sets out the approach to strip, map and record. As stated in paragraphs 5.3.24 – 5.3.25, Strip, Map and Record (SMR) is a flexible approach suited to areas of more extensive archaeological remains with few or no apparent focus of activity, or areas where the assessed significance of the remains is lower. The technique may also be applicable to particular construction impacts, such as utility corridors. As stated in paragraph 5.3.24 of the D7 DAMS, SMR is only applicable in sections of the Scheme outside of the WHS. Following stripping under archaeological supervision, sites for SMR will be subject to archaeological survey and mapping, resulting in a digital pre-excavation plan. In accordance with the research objectives identified in the SSWSI, a strategy for hand excavation based on this plan will be developed in consultation with Wiltshire Council and Historic England The sample excavation strategy would be identified as part of an iterative approach, in consultation with Wiltshire Council and Historic England. This approach does not require agreement of a baseline sample excavation percentage in the DAMS.
iii. Archaeological Monitoring and Recording	
• ***Para 6.5.10 - Agreement required on a***	This item was not covered at the issue specific hearing, and parties were invited to make any specific submissions in writing. **Post hearing note:**

baseline for the quantum of excavation.	The same generic sampling and recording methodologies for AER will apply to each AMR area. Paragraph 6.5.10 of the DAMS sets out the approach to archaeological monitoring and recording (AMR). This approach is intended to be applied in limited areas only, as outlined in paragraph 5.3.26. Exposed remains identified during AMR will be subject to archaeological survey and mapping. The amount of sample excavation of archaeological deposits/ features in each AMR area will be determined on-site in consultation with Wiltshire Council, Historic England and, for areas within the WHS, HMAG (taking account of the significance of the remains and the results of spot-dating of finds and the assessment of samples to achieve the aims and objectives of the SSWSI). This approach does not require agreement of a baseline sample excavation percentage in the DAMS.

5.5. Communications, etc

Agenda Item	Highways England response
i. Para 8.5.1 – Consultation on SSWSIs, etc and para 8.6.1 – Approval of Documents by Wiltshire Council. Are these arrangements acceptable, including the time periods allowed?	**Richard Moules, on behalf of Wiltshire Council**, raised three points with respect to section 8.5, in relation to including a validation stage, the scope of comments at the second round of comments, and the timeframe for comments on the revised document. **Post hearing note:** The DAMS submitted at Deadline 8 has taken on board the comments made by Wiltshire Council with respect to sections 8.5 and 8.6 of the DAMS.
ii. Para 8.6.5 – Appeals. Should such procedures also apply to disagreement with a decision of Highways England?	**Reuben Taylor QC, on behalf of Highways England**, explained that the appeals procedures should not extend to disagreement with a decision of Highways England. Mr Taylor QC explained that Highways England is the applicant and the DAMS sets out where approvals are required. The appeals process therefore only applies to those approvals. Where approval is not required, the DAMS provides that Highways England can make the decisions, provided it complies with all the other requirements applying to it, for example in relation to consultation, design vision, principles and commitments. Mr Taylor QC noted that if the Secretary of State makes the DCO and approves the DAMS as a certified document, the approach to decision making in the DAMS will have been approved. In response to comments from the **National Trust** in relation to HMAG being involved in the appeals process, Mr Taylor QC noted that this was subject to discussion, however, as HMAG would not be the party giving the approval the subject of an appeal, it is not surprising that the appeal process does not include HMAG. The appeal process would be between Highways England and Wiltshire Council. **Post hearing note:** The DAMS submitted at Deadline 8 includes amendments so that a party consulted by Wiltshire Council on the decision the subject of an appeal, will be able to be involved in the appeal.

	Responding to a submission from **George Lambrick of CBA** about the reference to highest practicable standards in paragraph 5.1.2 of the DAMS, Mr Taylor QC submitted that paragraph 5.1.2 was being over-read and needed to be read in the context of the other controls and the reflexive approach.

5.6. Reporting, etc

Agenda Item	Highways England response
i. Comments on the content of sections 9 and 10.	This item was not covered at the issue specific hearing, and parties were invited to make any specific submissions in writing.

5.7. Part 3 – Tables, Figures and References

Agenda Item	Highways England response
ii. Table 11-3: Summary of proposed mitigation areas and actions. Are the parties satisfied with these proposals, including treatment of stockpile areas? Should other areas be covered? ***iii. Table 11-4: Areas excluded from archaeological mitigation. Are the parties satisfied with the list, including the exclusion of proposed working areas?***	**Wiltshire Council, Historic England and National Trust** made brief submissions indicating these were matters under consideration or discussion.

5.8. Harm to the Outstanding Universal Value (OUV)

Agenda Item	Highways England response
• ***A1 – Should the HEMP be the product of three bottom section elements, rather than just the Main Works, HMP and Method Statement?***	**Reuben Taylor QC, on behalf of Highways England**, confirmed that Appendix A1 was incorrect and would be amended (this has been done in the DAMS submitted at Deadline 8).
• ***A4, A7, and A9 – Should the headings indicate approvals by statutory bodies as in A3, A5, A6, and A8?***	**Reuben Taylor QC, on behalf of Highways England**, explained that Appendices A4, A7 and A9 do not relate to activities or processes where an approval is required, rather they refer to implementation and monitoring of DAMS fieldwork (A4 and A7) and development of the post-excavation assessment report and updated archaeological research strategy (A9). This is why the headings do not refer to approvals by statutory bodies.
ii. Appendix D: Action Areas	
Comments and discussions	In response to submissions made about the deposition of spoil at Parsonage Down, **Reuben Taylor QC, on behalf of Highways England**, explained that Parsonage Down is identified in the action areas set out in Appendix D to the DAMS, as site number 6. Appendix D sets out the proposed archaeological mitigation for the site. Mr Taylor QC directed the Examining Authority to the Tunnel Arisings Management Strategy [APP-285] which provides detailed reasoning for identification of Parsonage Down and the benefits of using that site, which included consideration of archaeological impacts. **Post hearing note:** The impacts on the ploughed out field system at Parsonage Down are addressed in ES Chapter 6 Cultural Heritage, Appendix 6.8 Summary of non-significant effects [APP-217, Table 1.2, Page 2, heritage assets 1004.01 and 1004.02]. Although the Scheme intersects with numerous elements of the field system and disrupts its integrity, it is part of a much larger field system that stretches from the east side of Yarnbury Camp in the west to the River Till in the east, and therefore the Scheme impacts upon only a small proportion of the whole. The impact from the Winterbourne Stoke Cutting West, the east of Parsonage Down excavated material deposition area and the areas of landscape and biodiversity mitigation is assessed as a Minor Adverse and the resultant significance of effect is Slight Adverse on heritage assets 1004.01 and 1004.02 (field systems).
iii. Appendix E: Public Archaeology and Community Engagement	

Comments and discussions	This item was not covered at the issue specific hearing, and parties were invited to make any specific submissions in writing.

6. LANDSCAPE AND VISUAL

6.1. Landscape Character

Agenda Item	Highways England response
i. The introduction of significant engineering elements into the landscape.	This Agenda Item was covered previously in the agenda.
ii. The lighting scheme – Has technical modelling taken place? Requirement for a lighting strategy and responsibility for approval of a final highway lighting scheme.	**Richard Hammond, on behalf of Highways England**, confirmed that technical modelling had not taken place, and that the assessment undertaken was a non-measured assessment. Mr Hammond indicated that the assumptions the assessment conclusions are based on are set out at paragraphs 7.9.124 to 7.9.132 of Chapter 7 of the Environmental Statement [APP-045]. **Post hearing note:** Mr Hammond undertook to set out a summary of the assumptions in this written summary and these are set out below. In summary, the assumptions were that: • The proposed Longbarrow Junction would not be lit, nor would any section of the road, except under Green Bridge Four (day time only), within the tunnel and Countess Roundabout (replacement of existing lighting). • There would be traffic lights at Longbarrow Junction and therefore a localised source of glare. • The western approach cutting (i.e. the retaining walls) would not be lit, with the only sources of light being from vehicles within the cutting; • Tunnel portal lighting would be designed to minimise light spill outside of the portals' footprint; • There would be no street lighting on Countess Flyover, there would be1.8 metre high acoustic screens along the elevated section of the flyover; • There would be temporary lighting in operation when required at the crossover points indicated on the General Arrangement Plans, where traffic could be diverted onto one side of the dual carriageway (the crossover points are

located above the existing Countess Roundabout on the Countess Flyover and between Longbarrow Junction and the World Heritage Site); and

- Lighting under Green Bridge Four will only occur between dawn and dusk, be dimmer controlled, and be designed to minimise light spill outside of the bridge footprint.

These matters are all secured in the OEMP.

Mr Hammond submitted that it was appropriate and representative to undertake a non-measured assessment. Mr Hammond explained that a lighting strategy was unnecessary because the Scheme will be largely unlit and the OEMP includes various commitments in this respect and in relation to the lighting that will be provided.

Mr Hammond noted that in its D7 submission [REP7-043], Wiltshire Council has noted that it is in discussions with Highways England to withdraw the request for a lighting strategy, in exchange for adjustments to the OEMP provisions. In addition, the proposed legal agreement will deal with highway lighting in terms of new assets to be handed over. In their submission REP7-043, Wiltshire Council notes:

Discussions with HE are on-going and may lead to a modification of the Council's position in relation to e.g. a need for a Requirement in relation to highway lighting, which might be included in a modified OEMP text at MW-TRA12

And in REP7-042:

In regards to the Highway Lighting Scheme, the Council accepts that HE, as a responsible government-owned company, will not seek to undermine the spirit of the DCO at a later date through the introduction of new street lighting which might affect the Scheme. However, it is concerned that the lighting of the crossover points near Countess and Longbarrow Junctions has the potential to cause unwanted repercussions in relation to the WHS, dark sky impacts, local residents and users of the highway. Therefore, there is a need for such lighting to be subject to a degree of control beyond that of the (at this time unknown) maintenance contractor(s) undertaking maintenance, recovery work etc. which requires tunnel closures.

Richard Moules, on behalf of Wiltshire Council, confirmed that Wiltshire Council had originally suggested a requirement, but now considers the strategy in the OEMP to be satisfactory. Mr Moules noted that discussions continue. **Post hearing note:** At the Issue Specific Hearing on 30 August 2019 it was confirmed that, with the Council's OEMP wording in relation to Tunnel Closures being incorporated at Deadline 8, the Council had no further submissions on this point and no lighting requirement was necessary.

In response to submissions made by **Andrew Rhind-Tutt** about the position of the contraflow and its lighting, **Reuben Taylor QC, on behalf of Highways England**, noted that this point had been addressed previously in written submissions, and undertook to provide the relevant references in this written summary.

	Post hearing note: The Applicant has addressed Mr Rhind-Tutt's point as recorded in the written summary of oral submissions put at Traffic and Transport hearing on 13th June 2019, in relation to Agenda Item 6.1 [REP4-034].
iii. The night sky – technical modelling and testing?	**Richard Hammond, on behalf of Highways England**, explained that no technical modelling has been undertaken. Mr Hammond referred the Examining Authority to paragraph 7.6.153 of Chapter 7 of the Environmental Statement [APP-045] which confirms the assessment is non-measured. Mr Hammond confirmed the assessment was based upon a review of published information and night-time field work.

6.2. Visual

Agenda Item	Highways England response
i. Reprise on visualisations produced and outstanding requests including digital modelling of the site. ***ii. Landscape and Visual Impact Assessment (LVIA) Fig 7.107, View North from Blick Mead. At what point relative to Blick Mead would the flyover start its ascent?***	**The Examining Authority** referred to the latest set of visualisations submitted by the Applicant, noting that they were helpful. Some parties indicated they would like other visualisations, and were directed by the Examining Authority to identify those in their written summary (having confirmed that the recent set of visualisations submitted by Highways England did not satisfy the request). **Post hearing note:** The Examining Authority asked for confirmation from Highways England with respect to the difference in the existing road level and the level of the flyover in the Blick Mead image (Figure 7.107) and the landscape changes as shown in Figure 7.91, taken from Winterbourne Stoke looking towards Green Bridge 2. The Applicant will re-submit Figure 7.107 with chainages and the level differences to aid in relating the extent of the view with the engineering section drawings. View 7.91 is modelled correctly with Green Bridge no.2 in an elevated position with the landscape. The level difference between existing and proposed A303 can be seen in the Engineering Section Drawings (Plan and Profiles) [APP-010] sheet 4 of 24 (Green Bridge 2) and sheet 9 of 24 (Countess). These drawings show proposed levels (in pink), existing Levels (in green) and level difference (in black) at 100m intervals along the centreline of the proposed A303.
iii. Visualisations from the ex-A303 as a by-way under the Proposed Development.	The Examining Authority noted that Highways England had submitted useful visualisations in this respect.
iv. Reprise on the visual effects of adjustments within Limits of Deviation (LoD).	**Richard Hammond, on behalf of Highways England**, explained that the Landscape and Visual Impact Assessment [APP-045] did consider the maximum area of land anticipated as likely to be required, taking into account the proposed limits of deviation (LoD).

	Mr Hammond explained that the Landscape and Visual Impact Assessment (LVIA) [APP-045] is based on the works proposed in the DCO application (described principally in Schedule 1 of the draft DCO [APP-020] the works plans [APP-008] and the engineering sections [APP-010]) and the maximum area of land anticipated as likely to be required, taking into account the full extent of the proposed limits of deviation (LoD) for the Scheme (summarised in Table 2.1 of [APP-040]) and the flexibility of detailed design provided for in the DCO. The visual assessment took account of the worst-case scenario, whereby the Scheme was assessed at the maximum upwards and lateral heights of deviation, rather than the downwards LoD. This was because by being 'higher' in the landscape, or closer to a visual receptor, the Scheme would likely be more visible than if positioned 'lower' in the landscape. For the tunnel section within the World Heritage Site, the LVIA assessed the minimum length of canopy at the western and eastern ends of the bored tunnel. This was considered appropriate as it would be the worst-case scenario, whereby more of the retained cutting and vehicles beyond the tunnel would be theoretically visible. **Colin Shell** made submissions in relation to Highways England not making the full 3D model available, and also citing an article about Highways England using virtual reality techniques in connection with the Scheme. **Reuben Taylor QC, on behalf of Highways England**, noted that Highways England had previously responded as to why the digital model was not released. **Post hearing note:** The references to where Highways England has previously set out why the model was not released are provided in REP4-030: Written Summaries of oral submissions at ISH – Cultural Heritage, 5(iii), stating: • The model was developed as necessary to inform the consultation materials, assessments and design drawings required for the DCO submission. • It is a 3D model of the Scheme only, not a 3D model of the wider landscape. • It represents a working tool rather than a fully comprehensive complete model of every single component of the scheme. • When generating photomontages, that specific section of the model is brought into a fully complete state to generate the particular montage under consideration. • The process of generating the photomontage is verified to ensure accurate alignment of the model and the photo. Given the purpose for which the model was produced and utilised, the Applicant does not propose to release the 3D model **Post hearing note:** At the issue specific hearing reference was made by Colin Shell to an article in the magazine 'Infrastructure Intelligence' which provided an overview on how computer visualisations were being used in the design of the Scheme. The article can be found at the attached link: http://www.infrastructure-intelligence.com/article/feb-2019/how-digital-tools-are-bringing-projects-a303-stonehenge-upgrade-life

	In requesting greater access to 3D visualisations, Mr Shell asked why this information could not be made publicly available. In response, the visualisations referred to were used at public information events held during the consultation period, which ran from 8 February to 23 April 2018, and drive throughs of the Scheme as proposed then remain accessible on Highways England's consultation website: https://highwaysengland.citizenspace.com/he/a303-stonehenge-2018/ The article confirmed that an extensive package of visualisations, animated drive-throughs and interactive apps of the planned route and tunnel were produced which involved digitally recreating a photorealistic representation of around 16km2 of the existing site and surrounding English countryside, including the Stonehenge monument itself. In addition, an interactive virtual reality app, enabling the public to view the impact of the scheme across 360 degrees at key locations surrounding the site, was created and available to view via handheld devices at information events.

7. DESIGN

Agenda Item	Highways England response
Any matters not covered under 4.4 above	**Susan Denyer, from ICOMOS UK**, made submissions about the standards to be applied to the Scheme. **Reuben Taylor QC, on behalf of Highways England**, explained that in terms of the Scheme's impact on OUV and the WHS, the Scheme is already in a position of providing enhancement, and there is no legal or policy requirement to go further than this. Mr Taylor QC noted that there are numerous standards applying in numerous documents, and great detail is provided in this respect in the DAMS, OEMP and other strategies. The necessary and appropriate standards are applied in line with policy and to meet legal tests as to what is required for mitigation. The appropriate standard has to be applied in relation to the particular consideration. Mr Taylor QC confirmed that this has been done with great care throughout this process. What has been done does provide the exemplary approach appropriate to a Scheme in this location.

8. BLICK MEAD HYDROLOGY

If monitoring (and any associated remediation) is required for groundwater levels at Blick Mead during construction, and post construction, how should this be secured?

Agenda Item	Highways England response
a) Through the OEMP? ***i. Would an additional sub-category to the Groundwater Management***	**Reuben Taylor QC, on behalf of Highways England**, noted that Highways England's response on this Agenda Item 8 was without prejudice to its position. Mr Taylor QC confirmed that the effects on Blick Mead were considered as part of the Groundwater Risk Assessment, and the requirement to update it is set out at OEMP requirement MW-WAT10 (b). Mr Taylor QC confirmed that as effects on Blick Mead were considered as part of the Groundwater Risk Assessment, the requirement to update the Groundwater Risk Assessment for the final design and construction plan will therefore include consideration of

Plan, secured through MW-WAT10, adequately deal with this? ***ii. What wording should be used? eg Groundwater level and quality monitoring, reporting programme, trigger levels and action levels/ mitigation/ action plans for exceedances for Blick Mead.*** ***iii. What reporting criteria would be appropriate given the non-designated status of the asset? ie should Wiltshire Council's role be expanded beyond their function as lead local flood authority to include heritage considerations?***	Blick Mead. Any monitoring that is considered to be required as a consequence of that updated Groundwater Risk Assessment can then be developed as part of the Groundwater Monitoring Plan monitoring proposals required by paragraph (c) (which could include the post construction period if required) and associated mitigation plans under paragraph (d). This matter is therefore secured in the OEMP already. Mr Taylor QC confirmed that in terms of the bodies for consultation, this is already dealt with in MW-WAT10, and in light of amendments notified to the Examination today, approval of the plan would change to the Secretary of State, who would therefore retain control. In response to a question from the **Examining Authority**, Mr Taylor QC confirmed that this approach relies on that implicit understanding, as set out above. Mr Taylor QC noted that it would be open to include additional words – for example, at the end of the first sentence *'including in particular at Blick Mead*', and a new paragraph (f) as follows: '*In respect of all of the above matters, the Plan must specifically indicate how Blick Mead is to be considered*'. Mr Taylor QC noted however, that Highways England did not consider the additional wording was necessary, given the consideration of Blick Mead was inherent in the existing provision. Mr Taylor QC explained that as there would not be any adverse impact at Blick Mead, there is no necessity to add explicit wording to the requirement; and in any event, it is already caught as currently drafted. Various interested parties made submissions about Blick Mead. Most submissions were not directly related to the Agenda Item, and have been addressed previously by Highways England as recorded in its written summary of oral submissions made at Issue Specific Hearing 2, in relation to Agenda Item 8 [REP4-030]. In response to a submission by Wiltshire Council in relation to the scope of their role as a consultee on the Groundwater Management Plan, Mr Taylor QC noted that if Wiltshire Council provided a consultation response to the Secretary of State on matters outside hydrology (such as archaeology), in its wider role, it is highly unlikely the Secretary of State would ignore those submissions. Mr Taylor QC noted that Highways England would discuss the wording further with Wiltshire Council. **Post hearing note:** This matter (OEMP wording, DCO wording and the role of Wiltshire Council) was further discussed at ISH10 and ISH11: please see the Summary of Case made at those hearings. In respect of item iii, Highways England has included changes to the OEMP at Deadline 8 to remove the words 'in respect of local lead flood authority' to the reporting criteria column to ensure Wiltshire Council can consider heritage aspects.
b) Through an additional Requirement ***i. What wording would be appropriate, including the***	**Reuben Taylor QC, on behalf of Highways England**, submitted that Highways England did not consider a requirement was necessary as the monitoring was already secured by the OEMP (as noted with respect to the previous Agenda Item). Mr Taylor QC noted that there was provision for an independent party, the Secretary of State, to have control of the Groundwater Management Plan under the OEMP, and a requirement was not necessary.

consultation and approval bodies? ***ii. Could this be phased to avoid a prohibition on any development commencing on all parts of the Proposed Development, before the details are approved?***	In terms of phasing, Mr Taylor QC noted that the OEMP ensures that measures in relation to the Groundwater Management Plan will form part of and be appended to the CEMP. The CEMP is required by the OEMP to be produced prior to the commencement of construction. The phasing is therefore dealt with by the OEMP provision. The Examining Authority asked Highways England what wording it would be comfortable with if a requirement was considered necessary by the Examining Authority and Secretary of State. **Post hearing note:** This was further discussed at the DCO hearing on 30 August, and a suggested draft requirement is set out in the summary of that hearing submitted at Deadline 8.
9. Any Other Matters	
10. Close of Hearing	

Appendix A – DEFRA Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009

www.defra.gov.uk

Construction Code of Practice for the Sustainable Use of Soils on Construction Sites

BIS Department for Business Innovation & Skills

wrap Material change for a better environment

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This document is also available on the Defra website.
http://defraweb/environment/land/soil/index.htm

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Cover Image: Soils on Construction Sites, photo courtesy of the RSPCA.

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September 2009

Contents

Summary

Soil is a fundamental and ultimately finite resource that fulfils a number of functions and services for society which are central to sustainability. Some of the most significant impacts on this resource occur as a result of activities associated with construction activity, yet it appears that there is a general lack of awareness and understanding of this need within the construction industry.

A Code of Practice has therefore been developed to assist anyone involved in the construction sector to better protect the soil resources with which they work. By following the guidance in the Code you will not only be able to help protect and enhance the soil resources on site but you may also achieve cost savings for your business.

A summary of the key messages in this Code of Practice is set out below:

Pre-construction planning

- Have a soil resource survey carried out on site by a suitably qualified and experienced soil scientist or practitioner (e.g. a member of the Institute of Professional Soil Scientists – www.soilscientist.org) at the earliest convenience and prior to any earthworks operations.
- Incorporate the results of the soil resource survey into the site working strategy (e.g. Site Waste Management Plan or Material Management Plan) ensuring liaison between the soil resource survey and other ground investigations.
- Ensure that you are informed of and follow waste regulations as necessary.
- Consider the use of sustainable drainage systems on site as these can provide more long term protection of soils beyond the construction phase, by facilitating the infiltration and attenuation of surface water.

Soil management during construction

- Prepare a Soil Resource Plan showing the areas and type of topsoil and subsoil to be stripped, haul routes, the methods to be used, and the location, type and management of each soil stockpile.
- When stripping, stockpiling or placing soil, do so in the driest condition possible and use tracked equipment where possible to reduce compaction.
- Confine traffic movement to designated routes.
- Keep soil storage periods as short as possible.
- Clearly define stockpiles of different soil materials.

Landscape, habitat or garden creation

- Ensure that the entire soil profile is in a condition to promote sufficient aeration, drainage and root growth.
- Safeguard and utilise on-site soil resources where possible. If importing soils, use a reputable supplier, establish the source of the soil and ensure it is suitable for the intended use.

About this Code

1. This Code of Practice for the sustainable use of soil on construction sites is a practical guide to assist anyone involved in the construction industry to protect the soil resources with which they work. It is particularly intended for use in England.

2. It contains guidance of interest to those involved at all stages of construction projects, from the developer, designer, contractor, sub-contractor (earthworks, landscape) and regulator.

3. Although the Code itself is not legislatively binding, by following it:
   - you will help protect and enhance the soil resources on site and achieve wider benefits for the environment;
   - you may achieve cost savings for your business;
   - it may help you to achieve your business sustainability targets; and
   - it may help you to meet legal obligations regarding waste controls.

4. The Code outlines current guidance and legislation concerning the use of soil in construction projects, before offering stage by stage guidance on the use, management and movement of soil on site.

5. The protection, use and movement of soil should be considered from the outset of a development project's planning, through its design and construction phases and on into future maintenance.

6. The Code provides guidance on the various stages of site development where soil should be considered and contains ten sections to provide practical advice on different aspects of using soil sustainably on construction sites:
   i. Knowing what soils are on site
   ii. On-site soil management
   iii. Topsoil stripping
   iv. Subsoil stripping
   v. Soil stockpiling
   vi. Soil placement
   vii. Sourcing and importing topsoil
   viii. Topsoil manufacture
   ix. Soil aftercare
   x. Uses for surplus topsoil

7. Each section explains the need for the advice and makes recommendations for good practice, including method statements, illustrations and a list of Do's and Don'ts.

8. The Code is complemented by Case Studies to demonstrate both good and poor practice, as well as a range of toolbox talks for use on site.

Introduction

1.1 Soil functions

1. Soil is a vulnerable and essentially non-renewable resource. One hectare of topsoil, the most productive soil layer, can contain up to 5 tonnes of living organisms and because it can take more than 500 years to form a 2cm thickness, it is in practical terms non-renewable.

2. Soil fulfils a number of functions and services for society which are central to social, economic and environmental sustainability. These are:
   - food and fibre production;
   - environmental interaction (with water and air);
   - support of ecological habitats and biodiversity;
   - support for the landscape;
   - protection of cultural heritage;
   - providing raw materials; and
   - providing a platform for construction.

3. Soil also has a large social function, through providing the basis for greenspace, including gardens, playing fields and public open space. The latter provides cultural and social benefits that include increased well-being, physical and psychological health, and connection with nature. It consequently plays an important part in how people live.

1.2 Soil and construction

1. Some of the most significant impacts on soil properties occur as a result of activities associated with construction. Construction activity can have adverse impacts on soil in a number of ways by:
   - covering soil with impermeable materials, effectively sealing it and resulting in significant detrimental impacts on soils' physical, chemical and biological properties, including drainage characteristics;
   - contaminating soil as a result of accidental spillage or the use of chemicals;
   - over-compacting soil through the use of heavy machinery or the storage of construction materials;
   - reducing soil quality, for example by mixing topsoil with subsoil; and
   - wasting soil by mixing it with construction waste or contaminated materials, which then have to be treated before reuse or even disposed of at landfill as a last resort.

2. Although planning approval is a pre-requisite to all development proposals and consideration of the impact on soil is an integral part of the environmental assessment process, there is no specific direct planning control on the sustainable use and management of soil resources on construction sites or a requirement for the monitoring of soil protection and sustainable reuse.

3. The guidance provided in this Code will help achieve good soil management at all stages of the construction process.

4. In addition to this Code, you should also consider the use of sustainable drainage systems on site as these can provide more long term protection of soils beyond the construction phase, by facilitating the infiltration and attenuation of surface water. Features such as permeable surfaces reduce soil sealing and help to increase water infiltration and can increase groundwater recharge, while swales and retention basins can temporarily collect surface water and reduce soil erosion from surface water runoff.

2.1 Waste legislation

1. The sustainable use of soil on construction sites is influenced by EU legislation related to waste, national recycling objectives and incentives, and UK regulation on waste.

Waste or not waste?

2. The construction industry is the largest single source of waste arisings in England, producing 90 million tonnes of inert waste annually, some of it soil. Protection and reuse of soil is fundamental to initiatives to reduce such waste.

3. Essential to the reuse of soil from construction sites or redevelopment projects is the initial determination of whether the material in question is regarded as waste within the legal definition of the term.

4. There is no definitive list of what is and is not waste. In determining whether surplus soil is or is not a waste, a number of tests have to be used to determine whether the material is being, is required to be, or is intended to be, discarded.

5. The *Definition of Waste: Development Industry Code of Practice* (DoWDICoP) is a voluntary Code launched in September 2008 (applicable to England and Wales) that was initiated to provide a clear and concise process to determine whether excavated materials on a development site constitute waste in the first instance, and to identify the point when treated waste can no longer be considered as waste. **This Code of Practice is no substitute for obtaining independent legal advice or for consulting the Environment Agency. Decisions on the definition of waste must be made in the light of all the specific circumstances of an operation or activity and in accordance with the current case law.**

6. There may be a certain degree of support between this *Code of Practice for the Sustainable Use of Soils on Construction Sites* and the DoWDICoP, particularly when compiling a Materials Management Plan and a Soil Resource Plan. There is however a clear distinction between the two Codes. The *Code of Practice for the Sustainable Use of Soils on Construction Sites* is to be used to protect soils and ensure adequate soil function (e.g. plant growth, water attenuation, biodiversity) during and after construction. The DoWDICoP is to be used to help determine whether materials on construction sites are classified as waste or not.

Strategic objectives

7. Central government objectives for waste management are outlined in the *Waste Strategy for England 2007* (Defra, 2007). Government is seeking to avoid the disposal of soil to landfill through recycling incentives and less onerous regulation of low-risk waste processes. A key target is to increase diversion of non-municipal waste (including soil) from landfill and to secure better integration of treatment processes with the aim of reducing waste by making products with fewer natural resources and a greater proportion of recycled components.

8. The reuse of soil is an important factor in the Waste Strategy and will consequently contribute to breaking the link between economic growth and waste growth with the dual benefits of reduced environmental impact and the preservation of natural resources.

Regulation

9. The Environment Agency is responsible for enforcing waste management legislation in England and Wales (Scottish Environment Protection Agency in Scotland) and regulation is discharged under the terms of the EU Waste Framework Directive. It is normally an offence to undertake waste disposal or recovery operations without being in possession of a Waste Framework Directive permit which in England and Wales is an Environmental Permit (Environmental Permitting (England and Wales) Regulations 2007).

10. Environmental Permits are designed to regulate higher risk activities that are defined either in terms of the waste types they accept, the volumes of waste they treat, or the complexity of the process itself.

11 Permits are more complex to apply for and operate than to register an exemption. They require an annual subsistence charge proportional to the degree of risk the process presents, are closely monitored during physical inspections by the Environment Agency to ensure compliance, and require the presence of an appropriately qualified 'Technically Competent Manager' in order to continue in operation.

12. There are a number of exemptions from Environmental Permitting prescribed in Schedule 3 to the Environmental Permitting (England and Wales) Regulations 2007. These exemptions range from small-scale storage to large construction projects involving the recovery of large quantities of waste. Exempt waste operations are subject to certain limitations and include the permitted types and quantities of waste, the methods of disposal or recovery and pollution control measures.

13. These exemptions are intended to provide a "lighter touch" form of regulation than an Environmental Permit and need to be registered with the Environment Agency. They have been developed to encourage reuse or recycling of low-risk materials in a controlled manner without causing pollution of the environment or harm to human health.

14. The exemptions from Environmental Permitting are currently being reviewed. More information can be found on the Defra website[1]. Development sites should contact the Environment Agency to confirm which Permit(s) or exemption(s) may be required for each specific development.

15. The Site Waste Management Plans Regulations 2008 came into force in England in April 2008 for all construction projects with a project cost exceeding £300k. They aim to reduce the amount of waste produced on construction sites and prevent fly-tipping. Amongst other requirements, the Site Waste Management Plan (SWMP) must:

    1. describe each waste type expected to be produced in the course of the project;
    2. estimate the quantity of each different waste type expected to be produced:
    3. identify the waste management action proposed for each different waste type, including re-using, recycling, recovery and disposal.

1 http://www.defra.gov.uk/environment/waste/management/exemptions/index.htm

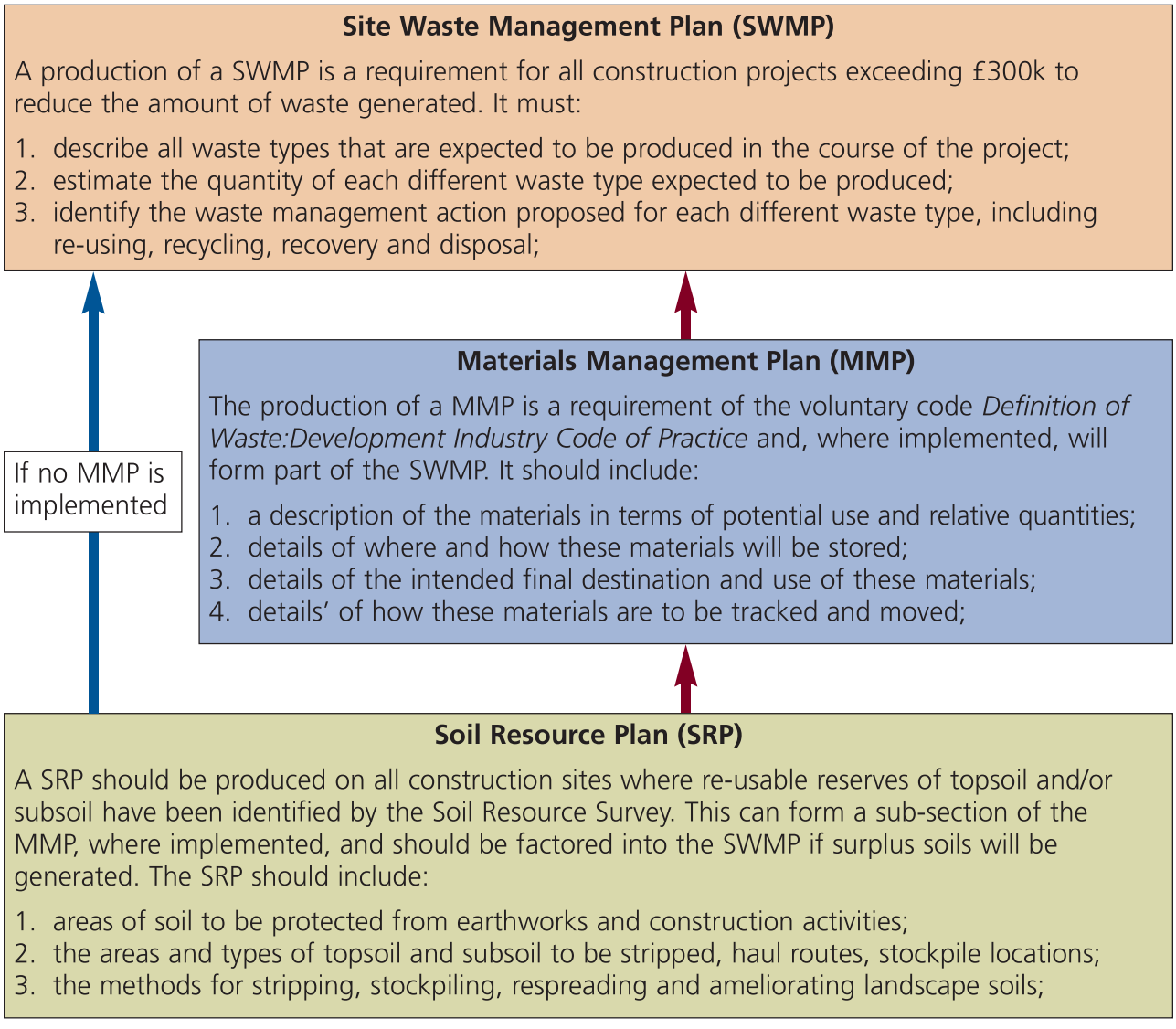
Recycling incentives

16. The Finance Act 1996 introduced the concept of Landfill Tax for "taxable disposals" of waste in landfill sites. There are two tax rates. The lower rate, for inactive materials (including soil), is currently £2.50 per tonne. This tax coupled with the cost of transport to landfill combine to represent a reasonable incentive to recycle soil.

17. The *Definition of Waste: Development Industry Code of Practice* (DoWDICoP) includes the development of a Materials Management Plan to ensure that developers, architects, engineers and contractors consider the issues surrounding waste legislation that may affect the reuse or recovery for all materials that will be encountered during a construction project. DoWDICoP may also be of assistance in preparing SWMP for construction projects, subject to the requirements of the Site Waste Management Plans Regulations 2008.

Plans

18. The diagram below sets out the hierarchal relationship of Site Waste Management Plans, Materials Management Plans and Soil Resource Plans (see Section 5.1).



2.2 Other legislation

1. There is a range of additional legislation that is associated with soil on construction sites, including:

   i. Agricultural Land (Removal of Surface Soil) Act 1953 – this places restrictions on the removal of surface soil from agricultural land without planning permission.

   ii. Clean Neighbourhoods and Environment Act 2005 – deals with problems affecting the quality of the local environment, including (amongst other things) waste. Section 5 of the act makes provision about the registration of carriers of particular kinds of waste, the illegal deposit of waste (fly tipping) and the powers of local authorities to collect and dispose of waste. This section also makes provision for dealing with waste at construction sites.

   iii. Environmental Liability Directive 2004 – this imposes obligations on operators of activities which cause or threaten to cause environmental damage to ensure the remediation of damage to (amongst other things) soil, through the restoration of the environment to its baseline condition.

   iv. Environmental Protection Act 1990 – this includes Part IIA on Contaminated Land which requires local authorities to identify contaminated land which poses a risk of harm significant to human health and the wider environment.

   v. Groundwater Regulations 1998 – to ensure proper control over the use and disposal of substances on land which could directly or indirectly pollute groundwater. These are categorised as List I and List II substances.

   vi. Town and Country Planning Act 1990 – this promotes the reclamation and reuse of derelict and contaminated land, including the reuse and management of soil on development sites.

   vii. Water Resources Act 1991 – this contains the primary provisions relating to the pollution of controlled waters, applicable to soil on constructions sites where operations result in erosion and runoff into a local watercourse.

Related guidance

1. Although there is various existing guidance on the care and use of soil for supporting the soft landscaping of construction projects, there is no overarching guidance on soil use and management at each stage of the construction process. The main items of related guidance are outlined below; these have been considered in the development of this Code:

British Standard code of practice for general landscape operations (excluding hard surfaces) (BS4428: 1989)

2. The *Code of practice for general landscape operations* (BS4428: 1989) contains recommendations for the following general landscape operations: preliminary investigations (including soil), land drainage, grading and cultivation, seeding of grass areas, turfing, amenity tree and woodland planting, and planting of shrubs, herbaceous plants and bulbs. More specialist amenity areas, such as sports playing fields, bowling greens, and golf courses are not covered by the Standard.

3. Although the Standard is often cross-referenced within specifications, it has in effect been superseded by more recent publications such as *National Building Specification Landscape* (outlined below) and landscape architects' own specifications.

British Standard specification for topsoil and requirements for use (BS3882: 2007)

4. The *British Standard Specification for topsoil* (BS3882: 2007) specifies the requirements for topsoils (natural or manufactured) that are moved or traded. It contains one main grade (multipurpose topsoil), which is suitable for the majority of needs, though specific-purpose topsoils have also been identified for specialist applications. The Standard also includes a section on the use and handling of topsoil. It is not intended (or appropriate) for the grading, classification or standardisation of in situ topsoil or subsoil.

British Standard Trees in relation to construction. Recommendations (BS5837: 2005)

5. The British Standard document, *Trees in relation to construction,* gives recommendations and guidance on the principles to achieve a satisfactory juxtaposition of trees (including shrubs, hedges and hedgerows) with structures. It provides guidance on how to decide which trees are appropriate for retention, on the means of protecting these trees during development, including demolition and construction work, and on the means of incorporating trees into the developed landscape.

Environment Agency advice

6. The Environment Agency provides a range of online advice for construction and building trades (see NetRegs website[2]) including a section on soil and soil stripping and a section on dealing with contaminated land.

7. The Environment Agency's *A guide for developers* (2006) provides practical advice on making developments better for people and the environment. Although references to soil are limited in this guide, it recognises the need to protect soil for its environmental and financial value.

Good practice guide for handling soils (MAFF, 2000)

8. The aim of the Ministry of Agriculture, Fisheries and Food's *Good practice guide for handling soils* is to provide comprehensive advice on soil handling to operators, soil moving contractors, consultants and planning authorities dealing with soil handling and

2 Available at: http://www.netregs.gov.uk

management on mineral extraction and waste sites. The guide is in the form of 19 Sheets, each providing detailed information on best practice methods for soil stripping, soil stockpiling, excavation from storage mounds, soil replacement, de-compaction and cultivation using different machinery combinations.

Guidance for successful reclamation of mineral and waste sites (Defra, 2004)

9. The Defra *Guidance for successful reclamation of mineral and waste sites* complements the MAFF *Good practice guide for handling soils*. It provides checklists and further guidance on soil use and handling, but is largely aimed at helping local government consider the adequacy of planning applications, restoration proposals and aftercare provisions for quarries and landfills.

Manual of contract documents for highway works: Volume 1 Specification for highway works (Highways Agency, 1998 plus a series of amendments 1998-2007)

10. The Highways Agency's *Specification for Highway Works* is used during the construction of new roads as well as the improvement or reconstruction of existing roads and bridges. It also covers such schemes as the installation of road lighting and traffic signals or other traffic signing schemes on existing highways. The Specification is divided into Series which cover a wide range of subjects in detail, such as site clearance, fencing, drainage, earthworks, pavement design, traffic signs, structures, electrical work, landscape and ecology.

11. Series 600 Earthworks and Series 3000 Landscape and Ecology deal with issues relating to the use and management of soil on highway schemes. These include: topsoil stripping methods, stockpiling methods and heights, subsoil preparation, depths of respread topsoil, treatments to topsoil, soil handling restrictions, seeding and planting and the management of landscape habitats.

National Building Specification Landscape (updated 2007)

12. *National Building Specification Landscape* provides specifiers, such as landscape architects, the ability to create up-to-date specifications and preliminaries for both hard and soft landscape projects. The specification is sub-divided into a number of sections but reference to soil is limited. The most relevant specifications for use of clean soils are in D20 (Excavating and filling) and Q28 (Topsoil and growing media).

Strategy for sustainable construction

13. A joint industry/Government *Strategy for Sustainable Construction* was launched on 11 June 2008. It lays out actions and deliverables relating to the key aspects of sustainability including the area of waste, and indicates that Defra and others will be looking at ways in which waste can be further reduced. Developing and rolling out tools, and improving our knowledge base, are important aspects of the future work indicated in the Strategy.

Sustainable drainage systems

14. The *Building Regulations Approved Document H* provides guidance on the incorporation of sustainable urban drainage systems (SUDS) and sets out a hierarchy of drainage options, with an adequate soakaway or other infiltration system being the preferred option.

15. Communities and Local Government have also strengthened the planning context for SUDS through *Planning Policy Statement 25: Development and Flood Risk*.

Related guidance

16. Detailed guidance on SUDS design, construction, operation and maintenance can be found in CIRIA publications C609 (Sustainable drainage systems – hydraulic, structural and water quality advice), C697 (The SUDS manual) and C698 (Site handbook for the construction of SUDS).

The Definition of Waste: Development Industry Code of Practice (DoWDICoP)

17. DoWDICoP was initiated to provide a clear and concise process to determine whether excavated materials on a development site constitute waste in the first instance, and to identify the point when treated waste can no longer be considered as waste. It applies to both uncontaminated and contaminated material from anthropogenic and natural sources (including topsoil and subsoil) excavated:

    - for use on the site from which it has been excavated, either without treatment or after on-site treatment, in the development of land;
    - for use in the development of land other than the site from which the material has been excavated, following treatment at an authorised treatment facility, e.g. Hub site within a defined Cluster project and used in the development of land.

18. **Principles for the Use of Materials as Non-Waste**

    The DoWDICoP indicates that there is no single factor that can be used to determine if something is a waste or when it ceases to be waste. In the context of excavated materials used on sites undergoing development, the DoWDICoP discusses the following factors to be of particular relevance:

    - Factor 1: Suitability for use without any further treatment
    - Factor 2: Certainty of use
    - Factor 3: Quantity of material

19. In order to demonstrate that the above factors are satisfied, the DoWDICoP requires a Materials Management Plan (MMP). The MMP should form part of a Remediation Strategy or Design Statement, which has been derived using an appropriate risk assessment. It is anticipated that the MMP will also form part of the SWMP for a development site. In summary, the MMP provides:

    - a description of the materials in terms of potential use and relative quantities of each category underpinned by an appropriate risk assessment;
    - details of where and, if possible, how these materials will be stored;
    - details of the intended final destination and use of these materials;
    - details of how these materials are to be tracked;
    - contingency arrangements that must be put in place prior to movement of these materials.

4.1 Knowing what soils are on site

Why?

1. Inadequate identification of clean soil resources not only risks good soil becoming mixed with spoil or contaminated materials, thereby restricting or preventing its reuse, but it will also result in the need to import soil for landscape works. This will inevitably increase the cost of the project.

2. Identification of topsoil and subsoil resources is also necessary as part of a construction site's Site Waste Management Plan or Materials Management Plan) as most greenfield developments generate surpluses of topsoil. This normally has to be exported from site.

How?

3. A soil resource survey, separate from a geotechnical or geoenvironmental survey, should be carried out on the site at the earliest convenience by a suitably qualified and experienced soil scientist or practitioner (www.soilscientist.org) and prior to any earthworks operations.

The Survey…

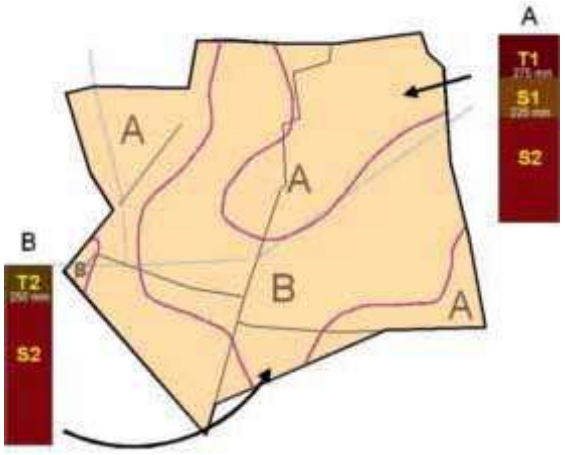
… will on most sites be carried out by a soil scientist using hand-operated soil sampling equipment, though some trial pits might be needed in order to investigate soil layers inaccessible by hand auger or the contents of stockpiles (if any are present on the site). The primary investigation should be based on a rectilinear or herringbone grid-based pattern with the characteristics of each soil layer (colour, texture, drainage characteristics and whether topsoil or subsoil) recorded. It can be combined with a geotechnical or geo-environmental survey provided that the relevant expertise is applied.

On large greenfield sites there should be at least one investigation every 10,000m^2 (1ha). On small greenfield sites or brownfield sites there should be at least one investigation every 5,000m^2 with a minimum of 10 locations investigated (further reference from BS3882:2007, BS5930:1999, BS10175:2001).

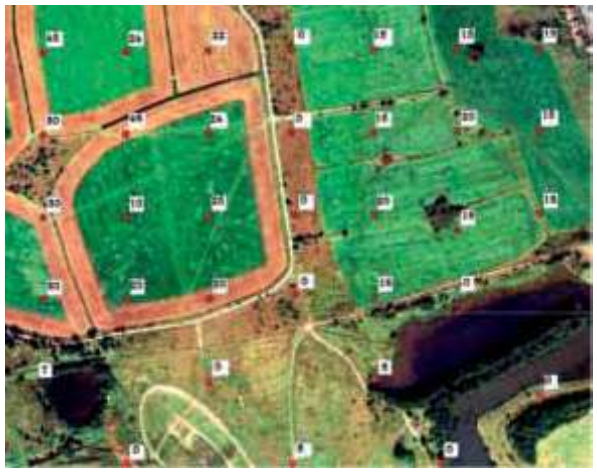
4. This needs to be co-ordinated with other site assessment surveys (e.g. contamination, ecology, archaeology, arboriculture, invasive weeds) to take into account any specific requirements of sites of designated environmental, ecological and archaeological interest. The survey should provide the necessary information to delineate, quantify and characterise the topsoils and subsoils of a site prior to these materials being excavated for reuse on or off-site.

5. The survey should include appropriate analysis of representative soil samples to adequately characterise the different soil materials (e.g. pH, salinity, particle size analysis, nutrients, organic matter, potential contaminants). The survey may be linked to, or draw on information in, a land classification survey that may have been carried out as part of the planning application process.

6. The results of the survey and analysis should be presented in an interpretive report that includes maps showing the location and extent of soil contrasting in any of the following parameters – texture, stoniness, organic matter content, compaction or permeability. The report should:
   - include a description of the characteristics of each soil resource;
   - discuss the suitability of the different soil materials for reuse; and,
   - make recommendations for the handling and storage of the identified soil materials in order to protect soil functions during site working.



Soil resources map, showing thicknesses of different topsoil resources (T1 & T2) and a good quality subsoil resource (S1).



Topsoil map of a proposed development site, showing variation in thickness (cm).

Samples…

… of any potentially re-usable soil resources should be taken, submitted to and appropriate UKAS/MCERTS accredited laboratory and analysed according to BS3882:2007, with soil materials of contrasting nature separately sampled and analysed. To ensure accurate representation of each sampling area, several incremental samples should be taken across it and mixed together to create one composite sample (minimum 2kg) for analysis. Sampling patterns based on a rectilinear grid or a random 'figure of W' are equally suitable.

If soil stockpiles are present, point samples should be taken at regular intervals from both the surface 1m and the core. One composite sample (minimum 2kg) should represent no more than 5,000m^3 of soil.

7. Further interpretations possible as site planning progresses and the landscape scheme is designed include:
   - preparation of a soil budget, including identification of any surpluses or deficiencies and storage requirements; and,
   - recommendations on how to improve the soil for the expected landscape use or habitat creation.

8. If soil resources surplus to requirement are identified these should be highlighted for inclusion within the MMP (as part of the SWMP) to establish sustainable off-site uses for the soil.

Do

- ✓ Undertake the soil resource survey before any earthmoving operations start.
- ✓ Ensure that the survey is carried out by suitably qualified and experienced soil scientist or practitioner.
- ✓ Ensure co-ordination between the soil resource survey and other ground investigations as each might have information useful to the other.
- ✓ Incorporate the results into the Material Management Plan or the Site Waste Management Plan.

Don't

- ✗ Rely on a geotechnical survey or contamination survey for detailed information on topsoil or subsoil resources.

Case Study 1: Amenity area of residential development

1. This area formed the final phase of a 2.7ha residential development that had been constructed between 2003 and 2006. The 950m^3 area had been occupied by site offices and equipment storage facilities over the construction period but, under the planning permission, was required to be reinstated to a condition suitable for creation of a children's play area with a financial contribution by the developer (a major UK housebuilder) for this and other local play provision.

Development layout with amenity area circled

Site preparation

2. Clearance of the site yard commenced in January 2007 with a requirement by the local authority for operations to be completed by the end of the month. The agreed specification for site preparation use was to strip existing materials (which were a mixture of soil and aggregate) to a depth of 300mm, remove to landfill and replace with clean soil. There was no investigation as to whether removal of this amount of material from the whole area was necessary, though there was one small area affected by a diesel spillage and which needed deeper removal of soil.

3. Stripping started on 16 January 2007 (Photo 5.1.1) by 360° excavator with lorries regularly arriving to take the excavated material to landfill. The weather in early January had been very mild and unsettled and, although rainfall for the month was near average, almost every day until work started had been wet.

4. Deliveries of topsoil started on 24 January, the morning after a brief cold spell had produced about 20mm of snow cover. The first tipper lorries delivering topsoil arrived as day broke, reversed onto the snow-covered wet subsoil and immediately became bogged down (Photo 5.1.2), creating deep ruts. Topsoil was tipped onto these (Photo 5.1.3) and spread out. Work progressed for several days with the exposed subsoil becoming progressively compacted over a large V-shaped area (Photo 5.1.4) as 35 lorries reversed over the subsoil to tip their load. The excavator driver, acknowledging that conditions were bad for soil handling, asked the developer's supervising representative whether they wanted the soil 'sprinkling' over the site or 'tracking down'. The request was for the land to be tracked down flat. It was pointed out to the developer's supervising representative that the

compaction created in the soil would cause ongoing drainage problems. He considered that this was relatively unimportant as it would only affect 'about a quarter of the site'. Tipping soil on the edge and moving it into place using the excavator had been considered but would take too long with the machinery hired in.

5. The soiling work was completed in three days and, during long periods of potential inactivity between deliveries of topsoil, the excavator driver repeatedly drove up and down the placed topsoil to try and level every minor undulation, thus causing additional compaction and leaving the surface prone to ponding after subsequent wet days (Photo 5.1.5).

6. There was little activity on the land for some weeks until contractors arrived to complete the site roads and stored paving materials and a small excavator on the edge of the area (Photo 5.1.5). These remained until roads and pavements were completed in mid-May but left a small area of soil contaminated with aggregate and brick which was removed from the site before a delivery of pebbly topsoil and final levelling of the site was undertaken on 1 June (Photo 5.1.6). After rain had made the stone content of the latest soil additions more evident, the site was hand raked and stone-picked before being handed over to the local authority.

Play area

7. Creation of the play area commenced on 12 June 2007 with delivery of storage containers and equipment. By 14 June torrential rain fell as a slow moving low pressure system brought storms to most of the country. By the morning of 15 June the site was saturated and draining only slowly because of the compacted soil, but machine digging of bases for the play equipment started. The result is illustrated by Photo 5.1.7. A further attempt at site work was made the following week, with similar results, so work was suspended and remained so during the extremely wet spell that characterised the following 10 days. Despite a somewhat drier July, surface water remained on the site for some weeks delaying recommencement of work until the end of the month. Works were eventually completed in mid September 2007.

8. Early indications are that water is ponding after minor rainfall and the expectation is that such drainage problems will continue.

5.1.1

5.1.2

5.1.3

5.1.4

5.1.5

5.1.6

5.1.7

Photographic record of site operations (from top left, moving across then down the page)

5.1.1 Clearance of site yard with hydraulic excavator removing upper 300mm of ground.
5.1.2 First delivery of topsoil with hydraulic excavator assisting bogged down delivery lorry.
5.1.3 Newly tipped topsoil being spread over snow, and ruts created by delivery lorries.
5.1.4 Large area of compacted subsoil created by delivery lorries reversing over the ground.
5.1.5 Paving materials stored on edge and surface ponding on compacted soil surface.
5.1.6 Additional levelling and topsoil spreading.
5.1.7 Creation of play equipment bases after heavy overnight rain.

Lessons learnt

- Insistence by the local authority that work should be completed in the winter (when installation of play equipment was not expected until summer) caused an unnecessary risk of soil damage.
- Given the situation imposed upon them, the developers should have adopted better work practices. Lorries returning from taking excavated spoil to landfill should have been used to bring in topsoil and could have then reversed onto ground still to be stripped in order to tip the soil on to the newly exposed subsoil. The excavator could then have pushed out the tipped topsoil to finished levels. This would have avoided all vehicle movements on soils. Final levelling and addition of any extra topsoil should then have been deferred until dry weather.
- Once an area is reinstated with soils it should not be used for storage of building materials but considered a 'no-go' area for all except landscape operations.
- There needs to be sufficient flexibility in site works to allow planned mechanised operations to be deferred if preceding weather conditions create unsuitable ground conditions.

Savings that could have been made

- Investigating what soil need to be removed instead of stripping the whole area to a depth of 300mm could have saved up to £5,000-£10,000.
- Using an improved work method that made better use of return loads could have saved the developer a portion of the transport costs.
- Avoiding compaction could potentially save the developer several thousand pounds if required to subsequently carry out remedial drainage work.
- Preventing the use of all parts of the newly soiled area for subsequent construction-related activities would have saved the £1,500 cost of removing stone contaminated soil and importing replacement topsoil.

5.1 On-site soil management

Why?

1. Careful management of topsoil and subsoil is an important aspect of sustainable use of materials that are being stripped, whether for sale off-site or for retaining on-site for later landscape preparation. Without a proper Soil Resource Plan there is the risk of losing, damaging or contaminating valuable soil resources.

How?

2. For all but the smallest of sites where re-usable reserves of topsoil and/or subsoil have been identified, a Soil Resource Plan should be prepared as a defined sub-section to a MMP and may be factored into the SWMP. This should show the areas and type of topsoil to be stripped, haul routes, the location of each soil stockpile and the type of soil to be stored within it. If the site has insufficient room to stockpile soil it may be more appropriate to find a sustainable off-site use for the temporary surpluses and then import suitable soil later.

Soil Resource Plan

A Soil Resource Plan will normally form part of the Materials Management Plan (and may be factored in to the Site Waste Management Plan) for the site.

It should include the following:

- maps showing topsoil and subsoil types, and the areas to be stripped and left in-situ.
- methods for stripping, stockpiling, respreading and ameliorating the soils.
- location of soil stockpiles and content (e.g. Topsoil type A, subsoil type B).
- schedules of volumes for each material.
- expected after-use for each soil whether topsoil to be used on site, used or sold off site, or subsoil to be retained for landscape areas, used as structural fill or for topsoil manufacture.
- identification of person responsible for supervising soil management.

A Soil Resource Plan should not be so complicated that it is unworkable in practice.

3. Areas of soil to be protected from construction activities (e.g. retained trees, protected habitats, archaeology, invasive weeds) should be clearly marked out by barrier tape and exclusion signs. Haul routes should be no wider than necessary to accommodate two passing vehicles and should be stripped of soil down to a firm base. Indiscriminate vehicle movements across soil should be avoided.

4. Changes to the Soil Resource Plan, such as changed haul routes or different than intended stockpiling locations, should be clearly marked on plans readily accessible by relevant site personnel.

Do

✓ Clearly define soil types, areas of soil to be stripped, haul routes and stockpile locations on your Soil Resource Plan.

Don't

✗ Create haphazard stockpiles of soil on site.

Case Study 2: Comprehensive soil care for Channel Tunnel Rail Link

1. The Channel Tunnel Rail Link (CTRL) was the first major new railway to be constructed in the UK for over a century and the first high-speed railway. Section 1 runs for 74km from the Channel Tunnel through the county of Kent and joined the existing railway network on the outskirts of London. Section 2, completed in late 2007, links to Section 1 and continues the route to St. Pancras Station.

2. The route of Section 1 was almost entirely through agricultural land (with some woodland) and involved the disturbance of soil, not only permanently along the 175ha now occupied by the line, but also on 675ha temporarily used for construction compounds, mitigation earthworks, cut and cover tunnels, and storage of spoil.

Site planning

3. The protection of soil quality was almost entirely driven by agricultural land quality and the desire to minimise the impact of the scheme on 'best and most versatile' land. A Code of Construction Practice defined the environmental requirements of the project and an Agricultural Management Plan (AMP) was produced as a generic plan to be passed into contract documentation. Opportunities were taken at the planning stage to propose the use of derelict pits for disposal of surplus excavation spoil and subsequent restoration with subsoil and topsoil.

4. The AMP included a Schedule of Standards and Soil Handling Techniques and, as much of the emphasis was on restoring land that would only temporarily be needed for the project, it was based on best practice within the mineral industry. It included:
   - a pre-disturbance record of soil physical characteristics;
   - specification for land being restored to agriculture after temporary use;
   - a method of assessing suitability for handling soil based on plastic limit;
   - advice on stripping topsoil and subsoil to the correct depth;
   - recommendation of the most suitable equipment for soil handling;
   - advice on soil storage (e.g. topsoil no higher than 3m and subsoil no higher than 5m);
   - advice on alleviating compaction after replacement, and a requirement for a five-year aftercare scheme.

Implementation

5. After contracts were awarded by Rail Link Engineering in October 1988, successful tenderers had to produce their own work plans containing method statements as to how they were going to handle soil, a physical characteristics record of each parcel of land to be affected and a detailed reinstatement specification and target land quality. To do this each contractor had to appoint a consulting soil scientist.

6. A detailed audit trail had to be kept of all soil materials required for land being eventually reinstated and soil being retained for reuse in the restoration process had to be stored separately from those identified for reuse elsewhere or removal off site. Non-agricultural soils such as those from ancient woodland in the line of the route were characterised in detail and plans made to translocate the soil, sometimes in three separate layers, to receptor sites to recreate a similar soil profile on them. Soil stripping and placement depths were specified in detail and soil handling involved no trafficking of donor or replaced soil and direct movement from donor to receptor site wherever possible.

7. After each area was reinstated, a condition report was prepared by the contractor's consultant and agreed with Rail Link Engineering's supervising soil consultant with remedial actions agreed as required.

Contractor contribution

There were two specified work methods for soil placement:

- by box-scraper with subsequent loosening (by ripping) to a depth of 60cm
- by dumper and backacter, using the loose-tipping method which involves no vehicle movements over placed soil.

The contractor for the contract east of Maidstone had a lot of heavy clay soils to deal with and was not happy with the suggested methods. In discussion with his and Rail Link Engineering soil consultants the contractor proposed a method that was later successfully adopted. The procedure consists of building a relatively thick peninsula of topsoil out at pre-determined intervals over the respread subsoil. Dump trucks reverse along the peninsula, thus progressively extending it by tipping more topsoil at the end. Then a light tracked bulldozer is used to spread out the soil to the required thickness over the rest of the area. The method has subsequently gained favour with statutory authorities.

Starting a 'peninsula' of topsoil

Lessons learnt

- Through careful planning, soil sustainability issues identified at an early stage of a project can be carried through to become part of the environmental programme for the construction phase.
- A large infrastructure project such as the CTRL, and one impacting on such a large area of undisturbed land, can justify a high level of supervision by soil specialists during construction.
- Method statements devised prior to construction might need to be modified to meet specific on-site circumstances or incorporate new ideas.
- Close liaison between the client's consultant and the contractors' consultants ensured that soils were used sustainably throughout the projects.

5.2 Topsoil stripping

Why?

1. Topsoil is a finite resource and an important component of most landscape schemes within construction projects. It provides an anchorage and oxygen for plant roots, slowly releases nutrients, and, in conjunction with the underlying subsoil, retains moisture to sustain plant growth during dry periods. Once re-usable soil resources have been identified within a site it is important to strip them carefully for beneficial reuse on or off-site.

2. Not stripping topsoil from areas that are to be built on, regraded or trafficked by site vehicles will increase project costs, as the resource will be wasted.

Method

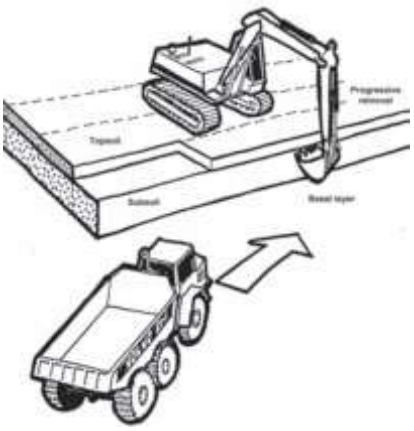
Remove surface vegetation by blading off, by scarification and raking, or kill off by application of a suitable non-residual herbicide applied not less than two weeks before stripping commences.

The method illustrated below is the preferred method for minimising damage to topsoil. It shows the transport vehicle running on the basal layer under subsoil as subsoil is also to be stripped. If only topsoil is to be stripped, the vehicle would run on the subsoil layer.

Stripping should be undertaken by the excavator standing on the surface of the topsoil, digging the topsoil to its maximum depth and loading into site or off-site transport vehicles.

Alternative stripping methods that can be shown to afford the same degree of soil protection are acceptable.

An archaeological watching brief might have to be accommodated during topsoil stripping.



How?

3. Before commencing work on site, topsoil from all areas that are to be disturbed by construction activities or driven over by vehicles should be stripped by earthmoving plant that is appropriate to the size of the site, the volume of soil to be stripped and haul distances.

4. The selection of appropriate equipment and work practices is also important because mishandling soil can have an adverse effect on its properties – not only fertility and permeability, but also ecological diversity, the performance and visual quality of vegetated areas and recharge of underlying aquifers. Mishandling also increases the risk of flooding and off-site discharges in breach of consents.

5. Topsoil will normally be stripped to a thickness defined by depth below the surface and/or a distinct colour change. Stripping topsoil too deeply so that subsoil becomes incorporated will reduce its quality and fertility.

6. The operation should be adequately supervised and follow a detailed stripping plan (part of the Soil Resource Plan) showing soil units to be stripped, haul routes and the phasing of vehicle movements. The soil units should be defined on the site with information to distinguish types and layers, and ranges of thickness.

7. Soil generally gains strength and becomes more resistant to damage as it dries. Consequently, it should be handled in the right conditions of weather and soil moisture and using suitable machinery in an appropriate way. Soil that is wet or very moist (wetter than the plastic limit) should ideally be allowed to dry further. The presence of growing vegetation is important as it helps soil dry out quickly to depth. Multiple handling of soil materials increases the risk of damage to soil structure so should be minimised.

Adverse weather

8. If sustained heavy rainfall (e.g. >10mm in 24 hours) occurs during soil stripping operations, work must be suspended and not restarted until the ground has had at least a full dry day or agreed moisture criteria (such as a specified soil moisture content) can be met. Lighter soil (e.g. free draining sandy soil) can generally be moved at higher moisture content with less risk of damage when compared to a heavy soil (e.g. clayey soil). The earlier or later in the year that soil is moved, the greater is the risk of causing damage or having work suspended by adverse weather, although the period when soil can be safely handled is longer in the drier eastern parts of the UK than in the west. Where the soil handling technique is such that trafficking over the soil is minimal the period for soil stripping may be extended.

Do

- ✓ Strip topsoil in the driest condition possible.
- ✓ Use tracked equipment wherever possible to reduce compaction.
- ✓ Confine movement of trucks or dumpers to designated temporary haul routes.

Don't

- ✗ Incorporate vegetation into topsoil to be stored.
- ✗ Strip soils during or after heavy rainfall or when there are pools if water on the surface.
- ✗ Strip topsoil too deeply so that subsoil becomes incorporated, thereby reducing fertility.
- ✗ Remove topsoil from below the spread of trees to be retained.

5.3 Stripping subsoil

Why?

1. The subsoil is an essential component of most soil, providing storage of moisture, transmitting rainfall to deeper layers or watercourses and enabling deep rooting by trees, shrubs and grass. Only soil that is shallow over rock lacks a subsoil layer. The subsoil plays an important role in reducing surface water runoff and erosion, controlling the waterlogging of surface layers, helping vegetation and crops to withstand summer droughts and providing anchorage for trees.

2. On many sites subsoil will not need to be stripped but merely protected from damage if it is within areas designated for landscape plantings. However, on other sites it might need to be temporarily removed to make way for haul roads or, if it is of a suitable quality, recovered and reused to manufacture a topsoil substitute (e.g. brownfield sites), or to be used on its own as a low fertility surface layer for specific plantings (e.g. species-rich grassland).

How?

3. Before commencing work on site, subsoil from all areas that are to be disturbed by construction activities or driven over by vehicles should be stripped by earthmoving plant that is appropriate to the size of the site, the volume of soil to be stripped and haul distances.

4. The selection of appropriate equipment and work practices is also important because mishandling soil can have an adverse effect on its properties – not only fertility and permeability, but also ecological diversity, the performance and visual quality of vegetated areas and recharge of underlying aquifers. Mishandling can also increase the risk of flooding and off-site discharges in breach of consents.

5. The operation should be adequately supervised and follow a detailed stripping plan showing soil units to be stripped, haul routes and the phasing of vehicle movements. The soil units should be defined on the site with information to distinguish types and layers, and ranges of thickness.

6. Soil generally gains strength and becomes more resistant to damage as it dries. Consequently, it should be handled only in the right conditions of weather and soil moisture and using suitable machinery in an appropriate way. Soil that is wet or very moist (wetter than the plastic limit) should be allowed to dry further. Multiple handling of soil materials increases the risk of damage to soil structure so should be minimised.

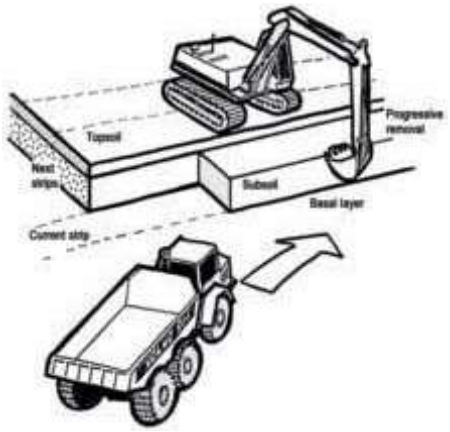
Adverse weather

7. If sustained heavy rainfall (e.g. >10mm in 24 hours) occurs during soil stripping operations, work must be suspended and not restarted until the ground has had at least a full dry day or agreed moisture criteria (such as a specified soil moisture content) can be met. Lighter (i.e. sandier) soil can generally be moved at higher moisture content with less risk of damage than a heavy (i.e. clayey) soil. The earlier or later in the year that soil is moved, the greater is the risk of causing damage or having work suspended by adverse weather, although the period when soil can be safely handled is longer in the drier eastern parts of the UK than in the west. Where the soil handling technique is such that trafficking over the soil is minimal the period for soil stripping may be extended.

Method

Topsoil should first be stripped from all areas from which subsoil is to be removed for reuse.

The preferred soil stripping method is illustrated below. Within each soil unit the soil layers above the base/formation layer are removed in sequential strips that can be up to 6m wide (the reach of a 360° excavator). Using an excavator bucket with teeth is preferable to using one without. Where there is a cover of topsoil, that layer is removed first before stripping subsoil to the specified depth. The soil transport vehicle runs on the layer beneath the subsoil.



Alternative stripping methods that can be shown to afford the same degree of soil protection are acceptable.

An archaeological watching brief might have to be accommodated during subsoil stripping.

Do

- ✓ Strip subsoil in the driest condition possible.
- ✓ Use tracked equipment wherever possible to reduce compaction.
- ✓ Confine movement of trucks or dumpers to designated temporary haul routes.

Don't

- ✗ Strip soils during or after heavy rainfall or when there are pools if water on the surface.
- ✗ Mix subsoils of different quality and composition.

5.4 Soil stockpiling

Why?

1. Soil often has to be stripped or excavated during the construction process. In order to enable its reuse on site at a later stage, soil needs to be stored in temporary stockpiles to minimise the surface area occupied, and to prevent damage from the weather and other construction activities.

How?

2. The main aim when temporarily storing soil in stockpiles is to maintain soil quality and minimise damage to the soil's physical (structural) condition so that it can be easily reinstated once respread. In addition, stockpiling soil should not cause soil erosion, pollution to watercourses or increase flooding risk to the surrounding area.

3. When soil is stored for longer than a few weeks, the soil in the core of the stockpile becomes anaerobic and certain temporary chemical and biological changes take place. These changes are usually reversed when the soil is respread to normal depths. However, the time it takes for these changes to occur very much depends on the physical condition of the soil.

4. Handling soil to create stockpiles invariably damages the physical condition of the soil to a greater or lesser extent. If stockpiling is done incorrectly the physical condition of the soil can be damaged irreversibly, resulting in a loss of a valuable resource and potentially significant costs to the project. The Soil Resource Survey and Soil Resource Plan should set out any limitations that the soil may possess, with respect to handling, stripping and stockpiling.

5. The size and height of the stockpile will depend on several factors, including the amount of space available, the nature and composition of the soil, the prevailing weather conditions at the time of stripping and any planning conditions associated with the development. Stockpile heights of 3-4m are commonly used for topsoil that can be stripped and stockpiled in a dry state but heights may need to be greater where storage space is limited.

6. Soil moisture and soil consistency (plastic or non-plastic) are major factors when deciding on the size and height of the stockpile, and the method of formation. As a general rule, if the soil is dry (e.g. drier than the plastic limit) when it goes into the stockpile, the vast majority of it should remain dry during storage, and thereby enable dry soil to be excavated and respread at the end of the storage period. Soil in a dry and non-plastic state is less prone to compaction, tends to retain a proportion of its structure, will respread easily and break down into a suitable tilth for landscaping. Any anaerobic soil also usually becomes re-aerated in a matter of days.

7. Soil stockpiled wet or when plastic in consistency is easily compacted by the weight of soil above it and from the machinery handling it. In a compacted state, soil in the core of the stockpile remains wet and anaerobic for the duration of the storage period, is difficult to handle and respread and does not usually break down into a suitable tilth. A period of further drying and cultivation is then required before the soil becomes re-aerated and acceptable for landscaping.

Stockpiling methods

8. There are two principal methods for forming soil stockpiles, based on their soil moisture and consistency.

9. Method 1 should be applied to soil that is in a dry and non-plastic state. The aim is to create a large core of dry soil, and to restrict the amount of water that can get into the stockpile during the storage period. Dry soil that is stored in this manner can remain so for a period of years and it is reuseable within days of respreading.

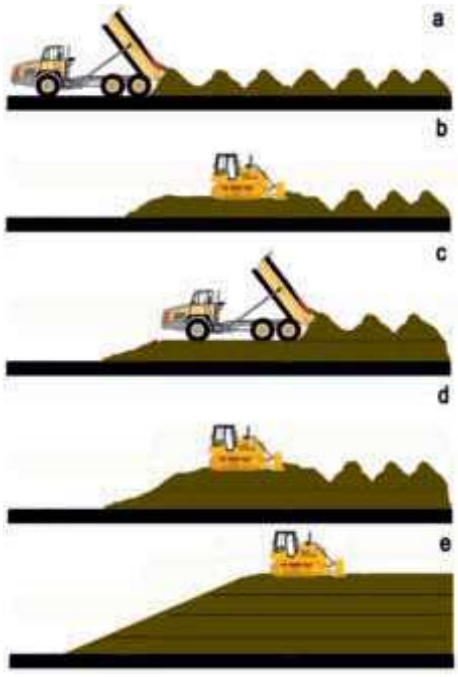
10. Method 2 should be applied if the construction programme or prevailing weather conditions result in soil having to be stockpiled when wet and/or plastic in consistency. This method minimises the amount of compaction, while at the same time maximising the surface area of the stockpile to enable the soil to dry out further. It also allows the soil to be heaped up into a 'Method 1' type stockpile, once it has dried out.

Soil stockpiling

Soil should be stored in an area of the site where it can be left undisturbed and will not interfere with site operations. Ground to be used for storing the topsoil should be cleared of vegetation and any waste arising from the development (e.g. building rubble and fill materials). Topsoil should first be stripped from any land to be used for storing subsoil.

Method 1 – Dry non-plastic soils

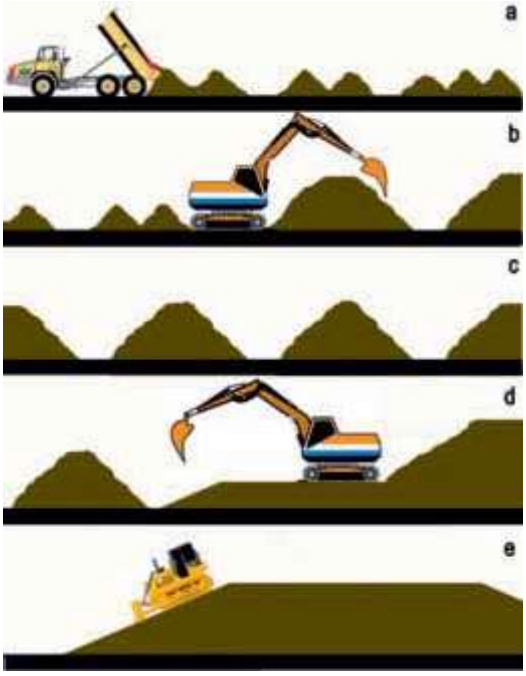
The soil is loose-tipped in heaps from a dump truck (a), starting at the furthest point in the storage area and working back toward the access point. When the entire storage area has been filled with heaps, a tracked machine (excavator or dozer) levels them (b) and firms the surface in order for a second layer of heaps to be tipped. This sequence is repeated (c & d) until the stockpile reaches its planned height. To help shed rainwater and prevent ponding and infiltration a tracked machine compacts and re-grades the sides and top of the stockpile (e) to form a smooth gradient.



Method 2 – Wet plastic soils

The soil is tipped in a line of heaps to form a 'windrow', starting at the furthest point in the storage area and working back toward the access point (a). Any additional windrows are spaced sufficiently apart to allow tracked plant to gain access between them so that the soil can be heaped up to a maximum height of 2m (b).
To avoid compaction, no machinery, even tracked plant, traverses the windrow.

Once the soil has dried out and is non-plastic in consistency (this usually requires several weeks of dry and windy or warm weather), the windrows are combined to form larger stockpiles, using a tracked excavator (d). The surface of the stockpile is then regraded and compacted (e) by a tracked machine (dozer or excavator) to reduce rainwater infiltration.



Stockpile location and stability

11. Stockpiles should not be positioned within the root or crown spread of trees, or adjacent to ditches, watercourses or existing or future excavations. Soil will have a natural angle of repose of up to 40° depending on texture and moisture content but, if stable stockpiles are to be formed, slope angles will normally need to be less than that. For stockpiles that are to be grass seeded and maintained, a maximum side slope of 1 in 2 (25°) is appropriate.

Stockpile protection and maintenance

12. Once the stockpile has been completed the area should be cordoned off with secure fencing to prevent any disturbance or contamination by other construction activities. If the soil is to be stockpiled for more than six months, the surface of the stockpiles should be seeded with a grass/clover mix to minimise soil erosion and to help reduce infestation by nuisance weeds that might spread seed onto adjacent land.

13. Management of weeds that do appear should be undertaken during the summer months, either by spraying to kill them or by mowing or strimming to prevent their seeds being shed.

Clearly defined stockpiling of different soil materials

Long term stockpile of stripped topsoil left with only weed vegetation

Waste regulations

Whenever it is envisaged that the use of the materials will occur in excess of one year from being stockpiled/stored, a time limit has to be agreed with the Environment Agency. The decision relating to the length of storage will be made within the context of the extant planning permission or agreed programme of works. Supporting information may be requested by the Environment Agency in the form of the Soil Resource Plan (e.g. site plans, cross sections and stockpile management).

Do

- ✓ Remove vegetation and waste materials from storage areas before forming stockpiles.
- ✓ Manage the site so that soil storage periods are kept as short as possible.
- ✓ Stockpile soils in the driest condition possible.
- ✓ Use tracked equipment wherever possible to reduce compaction.
- ✓ Protect stockpiles from erosion by seeding or covering them.
- ✓ Use clear signage to identify the content of stockpiles.

Don't

- ✗ Stockpile soils when wet or plastic.
- ✗ Stockpile soils of different quality and composition together, especially topsoil and subsoil.
- ✗ Stockpile subsoil or waste materials on top of topsoil.
- ✗ Locate stockpiles close to retained trees, drains, watercourses or excavations.
- ✗ Steepen stockpile sides beyond a slope of 1 in 1.75 (30°) in order to reduce the risk of erosion.
- ✗ Allow vehicles to run over stockpiles except during their construction.

Case Study 3: Poor gardens of housing development necessitate £90,000 of remedial work

1. This site was a greenfield development, where the original topsoil was stripped and stockpiled for later reuse in the gardens of houses and areas of public open space.

2. The topsoil was heavy loam, and was stripped and stockpiled during the winter months, when wet and plastic in consistency. As a consequence, the soil lost its structure and upon respreading the topsoil came out of the stockpile, in large, compacted, structureless clods. The subsoil was left in-situ during construction and became over-compacted by construction activities, including trafficking with wheeled plant and the storage of building materials.

Topsoil stockpiled when wet and plastic

Cloddy, compacted and structureless topsoil

3. Placement of topsoil was completed in winter 2005, with 150mm to 200mm of topsoil laid over subsoil that had not been ripped or decompacted. The gardens were laid to lawn using turf. The turf was healthy for the first summer, but by the onset of winter 2006 the turf began to rapidly fail and the gardens became waterlogged following periods of prolonged or heavy rainfall.

Failed garden turf

Surface water running onto adjacent paving

4. Examination of the soil in several gardens showed that the topsoil was structureless, waterlogged and anaerobic and the dead turf had begun to rot. There was virtually no root growth into the topsoil. The subsoil was relatively dry but heavily compacted. thus preventing drainage and resulting in flooding of adjacent areas such as garden patios.

5. In total, the gardens of eighteen houses out of twenty-seven had to be remediated, necessitating the temporary removal of fencing panels to gain access with machinery. The subsoil was decompacted using a single-tine ripper mounted on a small tracked excavator, and the texture and drainage of the topsoil was improved by amelioration with washed sand. All the turf had to be replaced.

6. The whole operation was undertaken at considerable cost to the developer.

Soil management during construction

Lessons learnt

- The characteristics of the site topsoil and subsoil and their limitations for reuse in landscaping should have been identified at an early stage of the development by undertaking a Soil Resource Survey.
- There was no guidance (such as a Soil Resource Plan) available to the earthworks contractor to advise on methods for stripping or stockpiling soil.
- The subsoil should have been decompacted before spreading the topsoil, to improve rainwater soakage into the substrate.

Savings that could have been made

- Ensuring that the soils were fit for purpose before laying the turf would have avoided the considerable costs (£90,000) and loss of reputation associated with remediating the soils and replacing turf.

6.1 Soil placement

Why?

1. The establishment of new landscapes, gardens, or other greenscapes on construction sites often involves the respreading of stockpiled soil or the importation of soil. The manner in which this is carried out has a significant bearing on the soil's function, and particularly its ability to support new trees, shrubs and grass.

2. It is essential to provide a structured, uncompacted and well-aerated soil profile for the successful establishment and subsequent growth of plants and grass. However, where heavy machinery and large volumes of soil are excavated and stored, soil structure can easily be destroyed by over-compaction. This leads to problems of waterlogging and anaerobism, which are detrimental to plants in two main ways. Anaerobic bacteria produce ammonia and methane gases harmful to plant roots, and, without oxygen, plant roots are unable to take up water and nutrients. Restricted rooting increases the risk of trees being affected by wind throw (the uprooting of trees by wind).

3. The consequence of over-compacted soil is not only poor establishment or failure of plantings but also increased surface water runoff and surface ponding that reduces the visual and physical amenity of the landscape or garden and can contribute to localised flooding.

The symptoms of over-compaction of soil on the amenity areas of new housing estates: struggling trees; poor grass growth; and surface ponding after heavy rain.

How?

4. Almost all soil is physically degraded to a greater or lesser extent during soil stockpiling, handling and placement. The potential quality and the ultimate suitability of the soil depends on how well its soil structure is restored during placement.

5. Provided the soil is spread and prepared correctly, damage to soil structure can be kept to a minimum and the soil can usually recover to a healthy state quickly. In order to achieve this, it should be handled only when dry or slightly moist and using suitable machinery in an appropriate way. Multiple handling of soil materials increases the risk of damage to soil structure, so should be minimised.

6. The 'loose tipping' method, using dump trucks and hydraulic excavators to move and spread the topsoil, is the most appropriate method to use.

Loose-tipping method

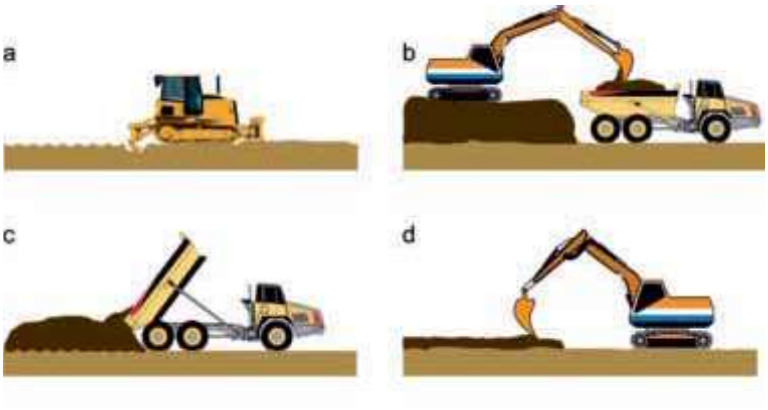
This method entails working to a strip system (the width of the strip determined by the reach of the excavator), and replacing soil sequentially across the soiling area. The receiving ground, whether a basal layer or compacted subsoil is first loosened with a wing-tine ripper.

A hydraulic excavator, fitted with a toothed-bucket to avoid excessive smearing, should be used to load the soil materials from the source area or stockpile into a dump truck which then discharges them onto the receiving surface. An excavator stands next to the newly dropped soil and spreads this to the required thickness. If there is to be more than one soil layer (i.e. if both topsoil and subsoil are being replaced) then the whole length of the strip is restored with subsoil before the process is repeated with topsoil. The topsoil is lifted onto the subsoil without the excavator travelling on the newly placed subsoil. Only when the strip has been completed is the next one started.

If soil is cloddy in structure, the excavator bucket can be used to break up the clods. Large stones can be removed during the operation.

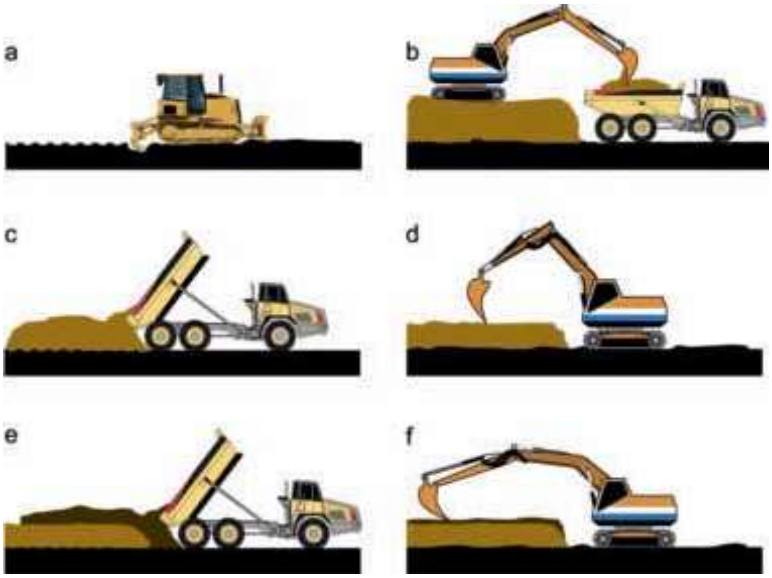
Modified versions of the loose-tipping method, for use when both subsoil and topsoil are to be placed, include spreading the subsoil as described above but then spreading the topsoil layer out using a low ground pressure dozer. Providing that soil conditions are suitably dry and dozer movements are minimised, this can gently consolidate the placed soil without causing over-compaction.

The loose-tipping method (topsoil spreading only)



a) loosening the subsoil of the receiving ground
b) loading of topsoil from stockpile
c) backtipping topsoil onto loosened subsoil
d) levelling topsoil

The loose-tipping method (topsoil and subsoil spreading)



a) loosening the substrate of the receiving ground
b) loading of subsoil from stockpile
c) backtipping subsoil onto loosened substrate
d) levelling subsoil
e) backtipping topsoil
f) spreading topsoil over subsoil using excavator working on substrate

Relief of compaction

7. On most construction sites, the receiving layer will have been compacted by vehicles, foot trafficking or the storage of building materials. Therefore, prior to spreading soil the substrate should be properly decompacted to break up any panning to reduce flood risk and to promote deeper root growth. A small (1-5 tonne) to medium sized (13 tonne) tracked excavator, fitted with a single rigid tine is effective in restricted areas, such as in planting beds and road verges. In more open areas, a tractor-drawn subsoiler is capable of loosening soil that is not too heavily or deeply compacted. In some instances, compressed air injection can be used to decompact the soil profile.

8. Deep compaction can only be effectively relieved using heavy duty ripper equipment, such as the single rigid tine device pictured below. For loosening to be most effective, it should be carried out when the soil is sufficiently dry to the full depth of working, otherwise the tine merely cuts and smears the subsoil rather than lifting, fracturing and loosening it. A toothed excavator bucket is not an appropriate tool for ripping soil.

Top (from left to right): *Ripping by tractor-drawn tines, Large winged-tine ripper, Topsoil rake used on a 3 tonne excavator*
Bottom: *Single ripper tooth used for relieving compaction to a depth of 600 mm*

Topsoil thickness

9. Topsoil placement thickness will depend on the anticipated rooting depth of the plants to be established and the quality of the underlying subsoil. Trees and shrubs require a much greater rooting depth than grasses, though this does not have to be made up entirely of topsoil. Topsoil at least 150mm deep is desirable for lawns and mown amenity grass and can beneficially be placed more deeply (up to 400mm thick) for trees and shrubs. However, topsoil does not normally perform well below a depth of 400mm from the surface, where there is an increase in self-compaction and where the biochemical oxygen demand (BOD) often exceeds the rate of aeration. This often results in the development of anaerobic conditions that are detrimental to plant root functions. Subsoil, which has a lower BOD, should, therefore, always be used to create rooting depths in excess of 400mm.

Topsoil cultivation

10. After respreading topsoil, any large, compacted lumps should be broken down by appropriate cultivation to produce a fine tilth suitable for planting (<50mm maximum aggregate size), turfing and seeding (<10mm maximum aggregate size).

11. Topsoil that has been stored in a stockpile is often compacted and anaerobic. It should therefore be cultivated to its full depth using appropriate tillage equipment to decompact and fully re-aerate. Only when the topsoil has been fully re-aerated will it be satisfactory for planting, turfing or seeding. More than one cultivation may be required to re-aerate the entire thickness of topsoil. Undesirable material (e.g. stones, fill materials and vegetation larger than 50mm in any dimension) brought to the surface during cultivation should be removed by picking or raking.

Adverse weather

12. If sustained heavy rainfall (e.g. >10mm in 24 hours) occurs during soil handling operations, work must be suspended and not restarted until the ground has had at least a full dry day or agreed moisture criteria (such as ‘drier than the plastic limit’) can be met. Lighter soil can generally be moved at a higher moisture content without damage than a heavy soil.

13. The earlier or later in the year that soil is moved, the greater the risk of causing damage or having work suspended by adverse weather, although the period when soil can be safely handled is longer in the drier eastern parts of the UK than in the west. Where the soil handling technique is such that trafficking over the soil is minimal (e.g. the ‘loose tipping method’ described above) the period for soil stripping may be extended.

Do

- ✓ Handle and place soil in the driest condition possible.
- ✓ Use tracked equipment wherever possible to reduce compaction.
- ✓ Decompact subsoil before placing topsoil.
- ✓ Fully re-aerate anaerobic topsoil before planting, turfing or seeding.
- ✓ Ensure that the physical condition of the entire soil profile (topsoil and subsoil) will promote sufficient aeration, drainage and root growth.

Don't

- ✗ Place or cultivate soils during or after heavy rainfall or when soils are plastic.
- ✗ Take construction machinery over topsoil or subsoil that has been placed.
- ✗ Place topsoil too deeply – 'more' is not necessarily 'better'.
- ✗ Plant into anaerobic topsoil.

Case Study 4: Decisions not to follow soil specifications cost company £25,000

1. Even where a good specification has been prepared for subsoil and topsoil management, there is seldom quality control of the works to ensure that desired outcomes are achieved.

2. An example is from a small development of 37 houses in Lancashire which necessitated the tipping of subsoil excavated from the development platform onto an adjacent field, which was then to be turned into public open space under a Section 106 agreement. A detailed specification was prepared by the developer's consulting landscape architect and stated that:
   - subsoil to receive topsoil should be thoroughly broken up to a depth of 150 mm and cleared of all roots, stones and debris with any one dimension greater than 75 mm;
   - subsoil should be graded after loosening but not traversed by heavy machinery;
   - topsoil should conform to 'BS3882:1994 fertile agricultural soils of uniform composition throughout, of light or medium texture with stones not exceeding 50 mm in any one dimension'.

3. Despite the detailed soil specification, including recommended quality control stages, neither the landscape architects nor other suitably qualified professionals were retained to supervise the contractors and check that the specifications were followed. Site clearance soil was used rather than fertile agricultural soil, the local planning authority was dissatisfied, refused to adopt the open space and legal action ensued. Investigation showed that the substrate was very compact and probably hadn't been loosened or stone picked, the topsoil had an excessive inclusion

One of many items of debris encountered in the imported topsoil during remedial works

of stones and debris (see image) and there was a mismatch between the soil and seed mix specified. Remedial works demanded by the local authority could have cost the developer £50,000 and costs of almost half that amount were eventually incurred.

Lessons learnt

- Close liaison between the developer, contractor and advisor should be retained throughout the project to ensure that the specifications and plans are followed.
- Soils should be loosened and stone-picked before spreading.

Savings that could have been made

- Ensuring that the soils were fit for purpose and that the specifications were followed would have avoided costs of £25,000 associated with remedial work.

6.2 Sourcing and importing topsoil

Why?

1. On many sites topsoil is either completely absent or there is insufficient quantity to meet landscaping needs. When site preparation commences, even on sites that have adequate topsoil, space constraints might necessitate sale or disposal off-site and importation of new topsoil later in the project.

How?

2. Before considering importing topsoil, soil resources on site should have been properly investigated through a Soil Resource Survey that evaluates the quality, quantity and suitability of all on-site resources (topsoil and subsoil) for the intended landscape scheme.

3. When it is necessary to source topsoil from outside the site, it is worth understanding the materials that are available in the construction industry, and the potential implications of using them for landscaping purposes. The term 'topsoil' can mean a whole variety of things, depending on whether you are buying, selling, hauling, using, specifying or testing the material. Many end-users still believe that all topsoil comes from green fields, but in reality, there are now a broad range of 'soil-based' materials sold as topsoil in the landscape and construction industry, and not all of them are suitable for the intended purpose.

4. There are essentially three main varieties of topsoil available, *Natural Topsoil, Manufactured Topsoil and Skip Waste Soil.* Over the last few years, the last two of these have increased in availability because of:
   - changes in legislation to promote recycling and waste recovery, and reduce the reliance on landfill.
   - increased production of organic soil improvers such as green compost and biosolids.
   - the decline of available natural topsoil, as less greenfield sites are developed.

Natural topsoil

5. Natural topsoil is derived as a by-product of development of greenfield sites and, sometimes, from undisturbed and uncontaminated areas of brownfield sites. It is illegal to remove topsoil (other than for turf-cutting) from agricultural or forestry land without planning consent. When sites are developed with the benefit of a consent, topsoil is normally stripped off before construction commences, and any surplus removed for reuse elsewhere. As a consequence, the availability of natural topsoil fluctuates as it only becomes available at the time of a topsoil strip and might not be available at all in urban centres remote from greenfield development.

6. Not all natural topsoil is suitable for all landscape use, as it can range from a crumbly loam to an acid, nutrient-deficient sand or a strongly alkaline clay. Whilst many topsoils are suitable for general landscape applications, those with more extreme characteristics are not, and their use can result in widespread plant failures. For example, silty topsoil is excellent for agricultural crop production, but makes very poor landscaping soil, due to its weak structure and poor handling ability. Temporary storage can also render topsoil unsuitable for its intended use.

Good, reusable natural topsoil

Damaged, heavy clay natural topsoil

Manufactured topsoil

7. Manufactured topsoil is a soil that is formed when two or more components are intimately mixed to form a rooting medium. Traditionally, these have been termed 'rootzones', and consist of a mixture of sand and natural topsoil at varying proportions, e.g. 70% sand and 30% topsoil. These are mainly used for sports applications, where they provide an ideal playing surface and free-draining rooting medium. As these are processed materials, using high value components, they are expensive. More recently a broader range of manufactured topsoil has become available, usually as the result of blending overburden and subsoils with various bulky organic materials, such as green compost and treated biosolids.

8. In many instances, these materials provide a good alternative to natural topsoil as long as the correct components have been selected and blended to correct ratios. Their attributes can potentially include consistent composition, year-round availability, and freedom from weeds and contaminants. However, the exact opposite can be the case where unsuitable soil or additives are used, or the manufacture process does not have the necessary quality control measures.

Skip waste soil

9. Unfortunately, one of the main alternatives to natural topsoil or properly manufactured topsoil is 'skip waste soil'. This is offered to the unsuspecting contractor or landscaper as 'general purpose topsoil' or 'turfing soil' or 'screened topsoil', from suppliers who have no supporting technical information to confirm the quality and suitability of their 'product'. This should not be confused with *natural topsoil* that has been screened to remove larger stones, as a means of improving its composition.

10. Skip waste soil is the result of screening materials derived from the 'muck away' site clearance operations. The coarse element is screened out and used as recycled aggregate whilst the fines (soil fraction) are sold as 'topsoil'.

11. Skip waste soils are often reused without the necessary Environmental Permit exemptions in place.

12. Skip waste soil usually consists of a mixture of topsoil, subsoil, clay and numerous fragments of building waste materials – brick, concrete, mortar, ash, clinker, and to a lesser extent asbestos, glass, metal, wood and plastic. In terms of its physical and chemical soil properties, the material is usually extremely alkaline, saline, infertile, and can often contain elevated levels of chemical contaminants (heavy metals, hydrocarbons) and 'sharps' such as glass and ceramic shards. This material often has a fine granular structure and may slump or cap when used as a landscape soil, leading to drainage and vegetation growth problems and even excess runoff.

13. However, as topsoil users are unaware of its detrimental characteristics, and see the material as 'soil', skip waste soil still finds a place in the landscape industry. Where it is inappropriately used to plant semi-mature trees or ornamental shrubs, this often results in either plant failure or, at the very least, stunted growth.

14. This material is at the fringe of the requirements for a landscaping topsoil. It does not normally meet the criteria for any of the British Standard BS3882 topsoil grades and would not be considered suitable for the majority of landscaping projects where, either the end-use is sensitive (e.g. domestic gardens), or the landscape scheme contains demanding trees and shrubs, or the creation of specific habitats.

15. Such soil materials may be considered for alternative uses within the construction and land restoration sectors (provided the necessary Environmental Permit exemption is in place), such as engineering backfill or acoustic bunds.

Topsoil assessment

16. To ensure that the topsoil is suitable for the intended purpose, or meets the contract specification, it is important to have the source independently assessed against a Topsoil Specification that sets out what should and should not be in the topsoil and that ensures that an effective growing medium is provided. The most functional specifications are those that list which properties the topsoil should possess prior to planting, turfing or seeding. These normally include:

    - Visual examination – soil structure, consistency, foreign matter, etc.
    - Particle size analysis (texture) and stone content.
    - pH and salinity values.
    - Content of major plant nutrients.
    - Organic matter content.
    - Maximum levels of potential contaminants (e.g. heavy metals, hydrocarbons, cyanide, phenols).

17. The values set against each property will vary depending on the required performance of the topsoil and will not be the same for every landscape project. It is often appropriate to have more than one specification if different 'landscape habitats' are to be established e.g. tree pits and wildflower grassland.

Sampling and testing

18. For topsoil that is to be imported to site, sampling techniques will vary, depending on whether the topsoil is still in-situ, or already stockpiled. Sampling should be undertaken by suitably qualified personnel.

    - Topsoil that has not yet been stripped should be sampled to its full depth. A separate topsoil sample should be taken from each of the different soil areas and from sub-areas of contrasting land use within them. To ensure accurate representation of each sampling area, several incremental samples should be taken across it and mixed together for analysis. Sampling patterns based on a rectilinear grid or a random 'figure of W' are equally suitable.

- From stockpiles, point samples should be taken at regular intervals from both the surface 1m and the core of the stockpile. A mechanical excavator might be necessary to sample stockpiles cores. Several incremental samples should be taken and mixed together for analysis. One composite sample should represent no more than 5000m^3 of topsoil.

19. The samples should be submitted to a suitably qualified, quality-assured laboratory (e.g. ISO 17025, MCERTS, UKAS). The samples should be analysed for the parameters listed in the Topsoil Specification. Additional tests to cover more parameters, such as permeability and porosity, should be considered on a site by site basis.

20. The results of analysis should be presented in a Certificate of Analysis, which will enable comparison with the contract specification or with the relevant British Standard.

Do

- ✓ Fully investigate on-site resources before considering a source of topsoil from outside the site.
- ✓ Use a reputable supplier.
- ✓ Establish the source of the topsoil and whether it is natural or manufactured.
- ✓ Ensure, through appropriate analysis, that the topsoil imported is suitable for the intended planting(s).
- ✓ Consider manufacturing your own topsoil.

Don't

- ✗ Accept non-documented or unverified loads of topsoil.
- ✗ Use a standard specification for all plantings as different species and land uses have different topsoil requirements.
- ✗ Accept topsoil that is too cloddy or wet or that contains visible evidence of plastics, concrete, etc.

Case Study 5: Prestige residential development benefits from careful soil investigation and specification

1. This residential development in Weybridge, Surrey was located on a 1.1ha site, which was partially wooded with mature trees and underlying scrub and partially rough grassland. The development comprised two executive detached houses with large front and rear gardens.

2. Given the vegetated state of the site it was envisaged that there would be sufficient topsoil for landscaping the gardens, and the soil would be of suitable quality. Nevertheless, prior to clearing the site, a survey by a soil scientist was undertaken to advise on the soil resources and to assist with finalising the landscape design. The survey identified very thin topsoil of a low quality and of inadequate quantity for the gardens. Below the existing topsoil was an intermittent iron pan that was impeding drainage and resulting in waterlogging above it (see image). These limitations were taken into account within the landscape design, which incorporated various measures to overcome them.

Site development

3. During site preparation the existing topsoil was recovered, ameliorated with fertiliser and compost and reused for low-value planting along the boundary of the site. No topsoil was removed from site. A specification was drawn up for topsoil to be imported for use in tree pits, shrub beds and lawn areas.

4. Due to the limitations of the subsoil, in particular the impeded drainage, and the high design expectations for the rear gardens, land drains were installed connected to a soakaway that was inserted into free-draining gravel deposits found at a depth of 2m below the subsoil.

Lessons learnt

- Not all Greenfield sites have a sufficient quantity or quality of topsoil for new developments. Just because a site is heavily vegetated doesn't mean there is a lot of topsoil or that the topsoil is good enough for reuse.
- Undertaking a Soil Resource Survey at the early stages of a development ensures that the necessary information is available in time to make modifications to the landscape design.
- Subsoil conditions must be considered as these affect the function of the topsoil.

Savings that were made

- Realising the limited soil resources of the site at an early stage ensured that the landscape design included measures to overcome the problems. There was no delay, and hence cost, to the project for re-design.
- There were no delays during landscape construction for sourcing imported topsoil or drainage materials.
- The landscape scheme was a success with no plant failures. This ensured that the properties looked their best when they came on the market and sold quickly.

6.3 Topsoil manufacture

Why?

1. The increase in brownfield site development has resulted in a shortfall of reuseable topsoil within many urban regions. Without a local source of topsoil, construction projects have to import natural topsoil from further afield or use waste soil of inferior quality. In response to these changes in development policy, techniques have been adapted to blend and process site-won or imported subsoil with organic materials to produce topsoil substitutes. This approach can offer several benefits including, cost savings, reuse of surplus subsoil, reduced transport movements to and from site, reduced landfilling and the use of recycled materials. Furthermore, as the process is controlled, the product can be modified to suit particular planting requirements by altering mixing ratios of the various components and/or adding particular materials to the mixture.

How?

2. Topsoil manufacture is the term given to the controlled process where a suitable soil-forming material or mineral component such as subsoil, waste sand or overburden is blended with an appropriate source of organic matter, such as green compost, spent mushroom compost or biosolids (sewage sludge), at the required mixing ratio.

Prior to construction

3. To determine whether topsoil manufacture is required and feasible for the project, the soil resources on site should have been properly investigated through a Soil Resource Survey. This should evaluate the quality, quantity and suitability of all on-site resources (topsoil and subsoil) for the intended on-site uses. Where a shortfall in topsoil is identified, the survey should consider the potential to manufacture topsoil from surplus subsoil (e.g. service trench arisings, foundation excavations). Other factors such as programme, available space and the type of landscape required should also be factored into this assessment.

4. If topsoil manufacture is possible, the Soil Resource Plan within the Materials Management Plan and/or Site Waste Management Plan for the project should be extended to include the methods, equipment and materials for topsoil manufacture. There are a number of methods and techniques that may be used for topsoil manufacture and these fall into two main categories, *in-situ* methods and *ex-situ* methods.

In-situ methods

5. In-situ methods are carried out directly at the soil's final location, where the organic and mineral components are spread out and thoroughly incorporated using conventional agricultural machinery and some more specialised equipment for certain tasks. This approach is efficient, but can be inflexible and needs a large operating area. As such, in-situ methods are normally best suited to large, open areas, accessible to tractor-drawn machinery.

Spreading organic matter onto subsoil

Incorporating organic matter with discs

Ex-situ methods

6. Ex-situ methods involve blending the necessary components using mobile quarrying and civil engineering machinery, including power screeners and loading shovels/excavators, before the soil is transported to its final location. This approach offers greater flexibility, and is best employed for smaller areas that are inaccessible to larger equipment, although a working area of reasonable size is required for the blending process.

Blending organic matter with mineral material

Blended topsoil

Waste regulations

7. Uncontaminated soil arisings that do not leave the site of origin are not considered to be waste (unless they are regarded as surplus to requirement after the development has been completed). However, if the use of the materials will occur in excess of one year from being stockpiled/stored, a time limit has to be agreed with the Environment Agency. The decision relating to the length of storage will be made within the context of the extant planning permission or agreed programme of works. Supporting information may be requested by the Environment Agency in the form of the Soil Resource Plan (e.g. site plans, cross sections and stockpile management).

8. Where soil or organic ameliorants are considered to be waste they are subject to waste management controls and an environmental permit or exemption needs to be in place.

9. Composted materials produced to the PAS100 standard and complying with the Compost Quality Protocol are considered to have ceased to be waste and the waste management controls do not apply.

Do

- ✓ Determine if there is a shortfall of site topsoil at an early stage in the project.
- ✓ Determine whether topsoil manufacture is feasible by considering the quality of surplus subsoil, programme, space and landscape requirements.
- ✓ Ensure that all soils and soil ameliorants are used in accordance with current Waste Regulations or comply with the relevant Quality Protocol.

Don't

- ✗ Wait until there is a stockpile of surplus subsoil before considering topsoil manufacture.

Case Study 6: Cost saving of £400,000 on major brownfield site construction project

1. Dartford Park, located on the site of the former Joyce Green Hospital and Littlebrook Lakes (gravel extraction and landfill) at Dartford in Kent, is a large-scale brownfield site development. The joint venture between ProLogis Developments Ltd and Dartford Borough Council proposes a comprehensive, mixed-use scheme for a combination of employment uses, Science Park with Innovation Centre, housing, local centre, primary school, leisure and recreational uses, open space and wildlife areas.

2. Dartford Park covers approximately 65ha of development land and incorporates an extensive soft landscaping scheme with a range of planting habitats, including semi-mature trees, ornamental and native shrubs, wildflower meadows and wetlands. Such a diverse scheme

requires a range of soil to support it. Given the site's brownfield status, it was initially assumed that it would have limited supplies of reuseable soil and the intention was, therefore, to import topsoil.

3. Initial geotechnical and geo-environmental investigations failed to confirm the quality of the soil for landscaping purposes. Consequently, as part of the development design, a soil resource survey was commissioned to identify available soil resources across the site. This involved a combination of desk study, site investigation and laboratory analysis and on-going liaison between the contractors and the consultants to the project (soil scientists, landscape architects, engineers and ecologists). The survey identified a broad range of soil and soil-forming material on the site that could be used to 'manufacture' the required topsoil for the proposed landscape scheme. These included low-grade topsoil, natural subsoil, demolition arisings, waste sand and greenwaste.

4. The information gathered during the soil resource survey was used to develop a Soil Resource Plan for the project. This was incorporated into the earthworks design and dealt with the effective recovery, storage and amelioration of the soil materials to produce a range of new topsoil and growing media.

5. This attracted cost savings of approximately £400,000 over importing topsoil, and the site has reserves of topsoil that will be used for further housing and infrastructure developments.

Lessons learnt

- Brownfield sites can have reserves of reusable soils.
- Geotechnical and geo-environmental investigations can provide useful background information, but they are not sufficient to identify soil resources for landscaping works, or to advise on the soil amelioration required to improve soils.
- Close co-ordination between contractors and consultants at the early stage of projects aids the development process and cost analysis.

Savings that were made

- The reuse of site-won soils and soil-forming materials saved approximately £400,000 on the development costs.
- The soils that were used would have been otherwise surplus to requirement, and therefore would have been removed off-site to landfill.
- Imported topsoils were not required, which meant that other natural topsoils were not used.
- The reduction in off-site disposal and importation of topsoil reduced lorry movements in and out of the site, thereby reducing pollution and transport congestion.

6.4 Soil aftercare

Why?

1. A well thought out and executed Soil Resource Plan will minimise damage to soil. Nevertheless, unseasonal adverse weather conditions or other factors can result in damage to soil structure that is not immediately repaired by cultivation. Structurally-weakened soil tends to settle and self-compact after placement, consequently suffering from waterlogging and anaerobism, conditions which are not only harmful to root function and plant health but can also contribute to erosion and flooding. Waterlogging and anaerobism are the most common soil-related causes for plant failure on landscaping schemes. Even in uncompacted situations it can take between 1 and 3 years for the soil structure to stabilise and provide the necessary drainage and aeration for plant roots and the soil's fauna and flora to function properly. Maintaining soil permeability is also an important element of Sustainable Urban Drainage Systems.

How?

2. A detailed landscape maintenance programme should be prepared in conjunction with the landscape design proposals. The landscape contractor that installed the landscape scheme is normally retained for a 1 to 5 year period to maintain the landscape scheme, often on a 'defects liability' arrangement. The maintenance should include monitoring of the soil conditions to identify unsatisfactory growing conditions. This can be achieved by hand digging small trial pits or auger holes at representative locations 2-3 times during each year and particularly a few weeks after planting or turfing. At this point the soil will usually show clear signs of adverse conditions, such as a grey or olive coloration and sour odour (indicating anaerobism), and/or water seepage (indicating waterlogged conditions). Treatments will vary according to the size and scale of the planting scheme and the degree of soil problems but the following are useful for general aftercare of amenity grass and trees and shrub planting.

3. It should be noted that using "best practice" methods for handling soil will reduce issues requiring remedial work. Where issues do exist it is preferable to identify and remedy them before planting shrubs and grass seeding areas.

Amenity grass

4. The most important treatment for either new amenity grass (turfed or seeded) or retained grass areas (often subjected to trafficking during construction) is decompaction and aeration. This can be achieved in a number of ways depending on the size of the area, access and depth required. Tractor-drawn or self-propelled equipment can be used to *verti-drain, slit* or *spike* the turf and topsoil to break up any panning and compaction.

5. This in turn improves aeration, drainage and root function. For small grass areas, or where access is limited, spiking the topsoil with a hand fork is also effective. Often treatments that can be considered include: fertiliser applications, herbicide application, top dressing with sand, soil or compost and over-seeding to improve the grass cover.

Trees and shrubs

6. Monitoring the soil conditions in new tree pits and shrub planting beds is essential to identify any problems before they harm the trees and shrubs. Tree pits can act as sumps for draining water which leads to anaerobic conditions, root rot and ultimately the deterioration or complete failure of the tree. If such conditions occur, opening up the pit to dry out the soil, and even pumping the stagnant water out, should be considered.

Planting areas

7. The application of wood or bark mulch to planting beds is widely practiced to reduce weed emergence and water evaporation. However, operation of spreading it requires trampling on the soil to gain access. Also, the weight of thick layers of mulch can consolidate the soil surface leading to poor water infiltration and gaseous exchange (aeration). The resulting compaction can be relieved by spiking the soil with a hand fork between the plants, which loosens and creates pores in the upper soil layer. On large areas, or where compaction is deeper than about 250mm, mechanised treatments can be employed to treat the soil without disturbing the plants. These include the injection of compressed air down to 1 metre to fissure and crack the soil. Various aggregates and additives can also be injected to keep the fissures open.

8. To maintain the fertility of the topsoil, applications of fertiliser should also be included within the maintenance programme, and particularly in the first few years. Compound, slow-release or controlled-release fertilisers are the most appropriate for tree and shrub topsoil, with one application often releasing a range of nutrients during the growing season.

Retained Trees

9. The soils supporting trees that have been retained on site during the construction may have suffered from disturbance or trafficking. Prior to handover, following completion of the development, an assessment should be made, and if necessary, remedial action taken to repair damage to the soil and roots. This may include enhancing soil structure, irrigation, improving fertility or inoculation with beneficial fungi.

Do

- ✓ Ensure that soil health as well as plant health is closely monitored during the aftercare period.
- ✓ Correct deficiencies as soon as they are detected.

Don't

- ✗ Rely on aftercare as an alternative to good soil management – careful soil handling, storage and placement will save on aftercare costs and result in long-term benefits to the development.
- ✗ Assume that soils will function adequately immediately after planting.

6.5 Uses for surplus topsoil

Why?

1. Soil is an important component for supporting life and performs a number of key environmental, social and economic functions. One hectare of topsoil, the most productive soil layer, can contain up to 5 tonnes of living organisms but because it can take more than 500 years to form 2cm, topsoil is in practical terms non-renewable. Yet in many localities, particularly urban areas, uncontaminated topsoil is in short supply for creating gardens, parks, roadside verges and landscaping schemes. Consequently it is important to try and avoid wastage of this important resource.

How?

2. Before deciding that soil is surplus to requirements, soil resources on site should have been properly investigated through a soil resource survey that evaluates the quality, quantity and suitability of all on-site resources (topsoil and subsoil) for the intended on-site uses. This should lead to development of a Soil Resource Plan as part of the Materials Management Plan and/or the Site Waste Management Plan for the project. Only when the required quantity has been set-aside for use on site for landscaping, gardens, etc. should other uses be considered.

Permanent storage created for surplus topsoil stripped from a greenfield site in Devon, despite there being demand for topsoil in the locality.

3. In reality, surplus topsoil is more likely to meet an off-site demand than subsoil, though there will sometimes be uses for the latter in restoring landfills, spoil tips, etc. or for blending with composts or biosolids to manufacture a growing medium that may have a commercial outlet. An off-site use for surplus topsoil should always be preferred to burial on site or sending it to landfill.

Prior to development

4. Discussions should take place with the groundworks contractors and the local authority to try and identify nearby land reclamation or brownfield development sites where soil resources are absent and where there is a realistic potential of using some of the soil surpluses that will be created by development. It should be noted that the potential might only be realised if the soil surplus is realised in the same period as the off-site demand exists.

	Area m^2	Topsoil		Subsoil	
		Thickness m	Volume m^3	Thickness m	Volume m^3
Yield					
Phase 1 units	11040	0.3	3312	0.25	2760
Phase 2 units	15110	0.3	4533	0.25	3778
Haul/access road	3433	0.3	1030	0.25	858
Stockpiling area	4500	0.3	1350	0	0
			10225		**7396**
Need					
Car park & road verges	1200	0.2	240	0.3	360
Southern park	4500	0.2	900	1.2	5400
Peripheral landscaping	3450	0.2	690	0.5	1725
			1830		**7485**
Surplus			**8395**		**0**

Example of a simple spreadsheet for soil surplus calculation. Excess subsoil is being used to create landscaping mounds in southern park

Waste permitting

5. Reference should be made to current waste legislation and guidelines (e.g. The *Definition of Waste: Development Industry Code of Practice* – September 2008), or enquiries made to the Environment Agency, to determine whether the surplus soil will be classified as waste or not.

6. If surplus soil arisings (including topsoil) do not leave the site of origin after the development has been completed they may be regarded as waste, and could be subjected to the appropriate Environmental Permit or exemption. Materials should be used in the quantities necessary for that use. The use of an excessive amount of soil will indicate that it is being disposed of and is therefore a waste.

7. Where soil materials (including topsoil) are exported from a construction site (even temporarily) they are classified as a waste.

8. If the soil can be 'fully recovered' and appropriately reused on another site (e.g. BS3882 certified topsoil reused for another landscape project), it can be dealt with using the relevant exemption within the Environmental Permitting (England and Wales) Regulations 2007. The main exemptions relevant to soil reuse are Paragraph 7 (land treatment – agricultural land) and Paragraph 9 (reclamation or improvement of land – non-agricultural land). These exemptions have to be notified to the Environment Agency and the notifications need to be accompanied by proof of benefit and a pollution risk assessment.

9. Alternatively, the soil needs to be taken to an appropriately permitted treatment facility for recovery or, as a last resort, be disposed of at landfill. If the surplus soil is sent to landfill it will be subject to landfill tax.

Landscape, habitat or garden creation

Do

- ✓ Calculate soil surpluses at an early stage in the project.
- ✓ Make use of contractor contacts and local authority knowledge to seek sustainable off-site uses.
- ✓ Ensure that all on-site and off-site uses are in accordance with Waste Regulations.

Don't

- ✗ Bury topsoil deeply on site unless there are no sustainable off-site uses and there is no risk to significant harm to humans and the wider environment.

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Glossary

Anaerobic	Oxygen-deficient
Basal Layer	Unweathered parent material beneath subsoil. Layer upon which subsoil may be respread.
Biochemical Oxygen Demand	The quantity of oxygen required by aerobic micro-organisms for the complete (aerobic) decomposition of a material.
Biosolids	By-product of sewage collection and treatment processes. They have been treated and/or stabilised to the extent that it is possible to beneficially reuse them. Also known as sewage sludge.
Contaminated soil	Soil containing harmful substances in such concentrations that are already causing or are capable of causing significant harm to humans, animals, plants, eco-systems, property or pollution of Controlled Waters.
Disposal	Waste management operation serving or carrying out the final treatment (i.e. treatment resulting in residues that are discarded) or final disposal (e.g. landfill) of waste, which is not intended to be reused for a useful purpose.
Green compost	A blend of botanical residues derived from garden and landscape wastes, for example grass cuttings, bark, wood, branches, leaves and weeds, composted to produce a dark organic and nutrient-rich material which is of benefit to soils and growing media to which it is added.
Groundworks	Movement of soils or rock by excavation and / or placement to create a platform for building, trenches, hollows, wells, shafts or tunnels.
MCERTS	The Environment Agency's Monitoring Certification Scheme provides a framework within which environmental measurements can be made in accordance with the Agency's quality requirements.
Non-plastic soil	A soil that does not exhibit plasticity at any moisture content, such as sand or gravel.
Plastic soil	A soil that, within a certain moisture content range, is capable of being moulded or deformed without rupture.
Plastic limit	The moisture content above which a plastic soil starts to exhibit plastic behaviour.
Ponding	The collection of water at the soil surface when there is no room available for it to infiltrate to the soil.
Recovery	Waste management operation where principal objective is to ensure the waste is reused to serve a useful and appropriate purpose.

Glossary

Ripper	Machine drawn equipment having tines capable of penetrating soil and loosening it.
Ripping	Loosening soil by the drawing through it of a tined implement.
Runoff	The flow of water over the ground surface.
Soil compaction	Over-compaction of subsoil or topsoil so that fine pores and the spaces between soil structure aggregates become closed and are unable to allow the passage of roots, water and air.
Soil contaminants	Substances which, when present in sufficient concentration, may inhibit soil function or cause a risk of significant harm to animals, humans or the environment.
Soil erosion	The detachment and movement of soil by the action of wind and flowing water.
Soil function	The ability of a soil to not only provide a platform for construction and raw materials but also provide a number of environmental services, including the support of vegetation growth, ecological habitats and biodiversity, regulating the through-flow of water, degrading, storing and transforming soil organic matter, nutrients, wastes and contaminants, and protecting archaeological remains.
Soil Resource Plan	Sets out in detail the methods, equipment, location and programme for the recovery, storage and reuse of all site topsoil and subsoil.
Soil quality	The capacity of soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health.
Soil resource	The nature and volume of different qualities of topsoil and subsoil that have a potential for beneficial reuse.
Soil resource survey	A survey undertaken to delineate, quantify and characterise the topsoils and subsoils within a site.
Soil sealing	Covering of the soil surface with an impermeable material.
Soil structure	The aggregation of soil particles into larger units with spaces between that allow flow of air and water and root penetration.
Soil texture	A descriptive classification reflecting the proportions of mineral fractions (sand, silt and clay sized particles).
Spent mushroom compost	A versatile and useful compost derived from the decomposition of commercially-grown mushroom growing media, which is usually composed of straw, manure, gypsum and/or lime.

Subsoil	Weathered soil layer extending between the natural topsoil and the little weathered basal layer (e.g. geological parent material) below, or similar material within a landscaping project on to which topsoil can be spread. Subsoil usually has a lower organic matter and plant nutrient content than topsoil.
Subsoiler	Similar to a ripper (see above) but often with wings on the foot of the leg(s) to increase soil heave and shatter.
Topsoil (manufactured)	A material produced by combining mineral matter and organic matter of suitable quality (and, where appropriate, fertiliser and lime) that provides similar functions to natural topsoil.
Topsoil (natural)	Upper layer of a soil profile, usually darker in colour and more fertile than the layer below (subsoil), and which is a product of natural biological and environmental processes. The thickness of natural topsoil will vary from only a few centimetres in some sites to more than 350mm in deeply cultivated agricultural sites.
Verti-draining	The process by which a verti-drain machine punches holes (up to 300mm deep) into the soil using solid or hollow tines. This process lifts and shatters the soil to relieve compaction and improve aeration and drainage.
UKAS	The UK Accreditation Service is the sole national accreditation body recognised by government to assess organisations that provide certification, testing, inspection and calibration services.

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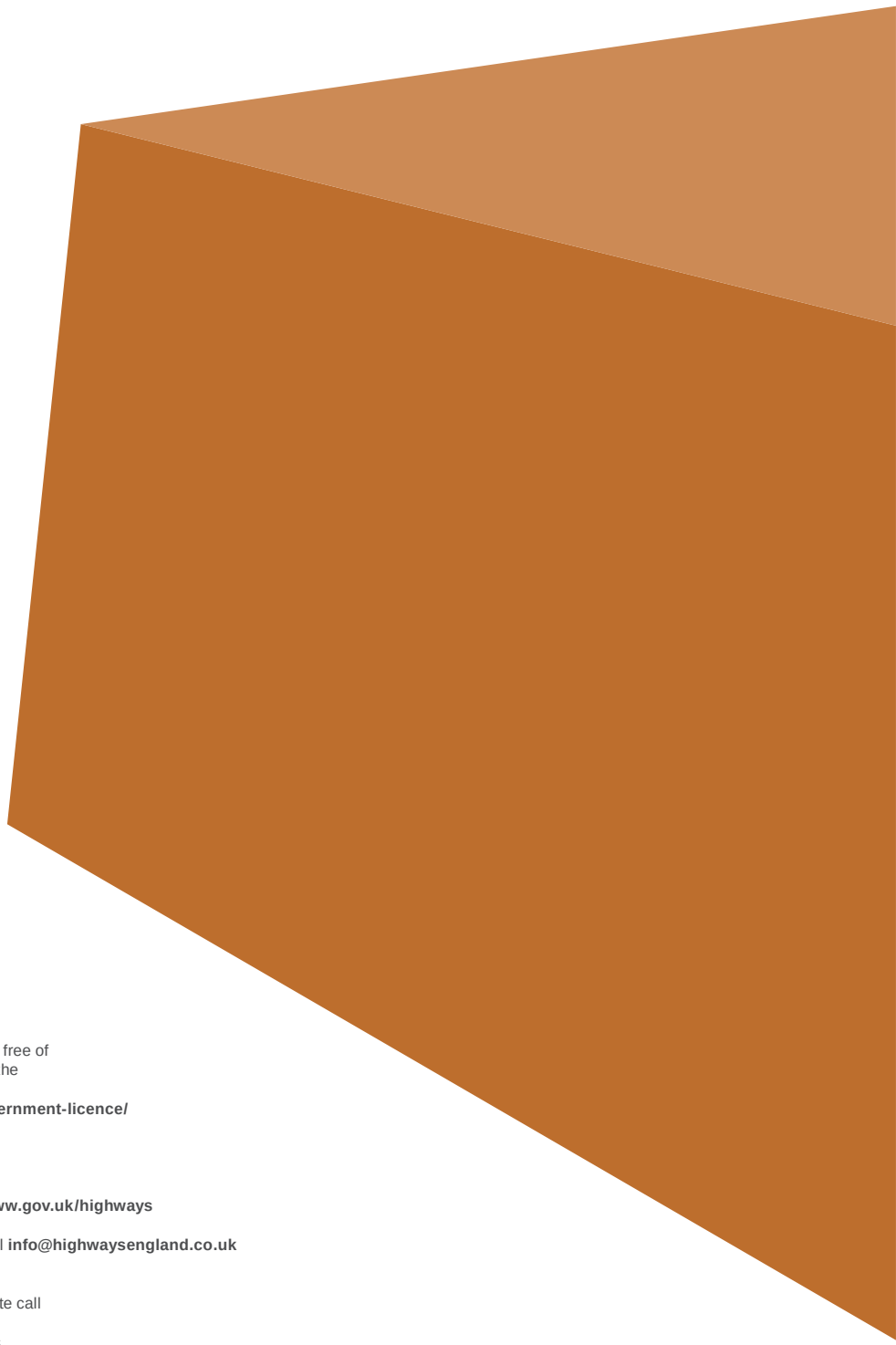

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