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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix CT-001-00001_Part 2

Cross-topic

Environmental Impact Assessment Scope and Methodology Report - Part 2 of 3

M94

December 2021

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Department for Transport

High Speed Two (HS2) Limited has been tasked by the Department for Transport (DfT) with managing the delivery of a new national high speed rail network. It is a non-departmental public body wholly owned by the DfT.

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1 Introduction

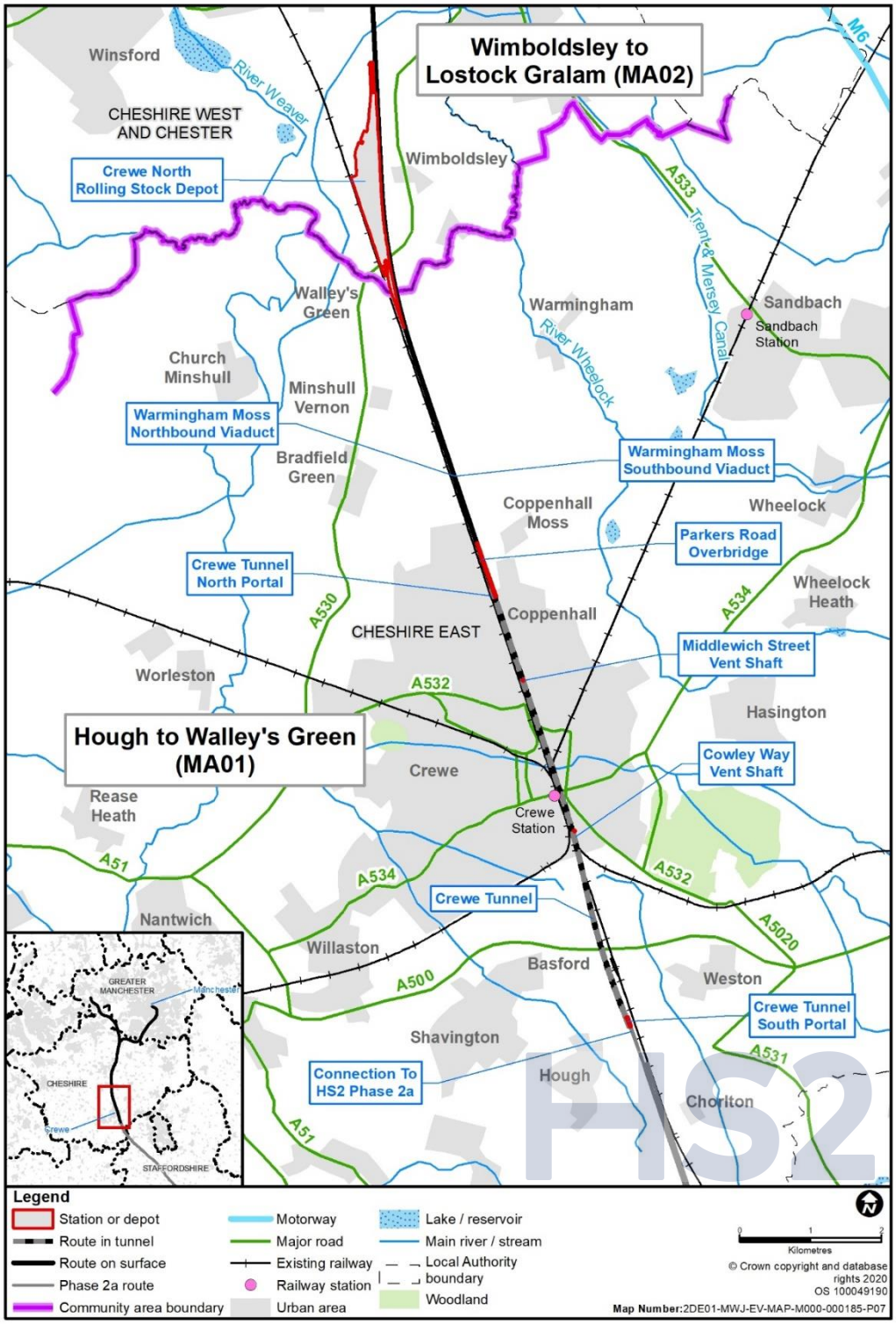
1.1 Scope and Methodology Report Part 2

1.1.1 This is Part 2 of the Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR). It contains the following annexes:

- Annex B – Maps of the Proposed Scheme;
- Annex C – Air quality technical note;
- Annex D – Community technical note;
- Annex E – Ecology and biodiversity technical notes;
- Annex F – Electromagnetic interference technical note; and
- Annex G – Health technical notes.

Annex B – Maps of the Proposed Scheme

Figure 1: MA01: Hough to Walley's Green community area



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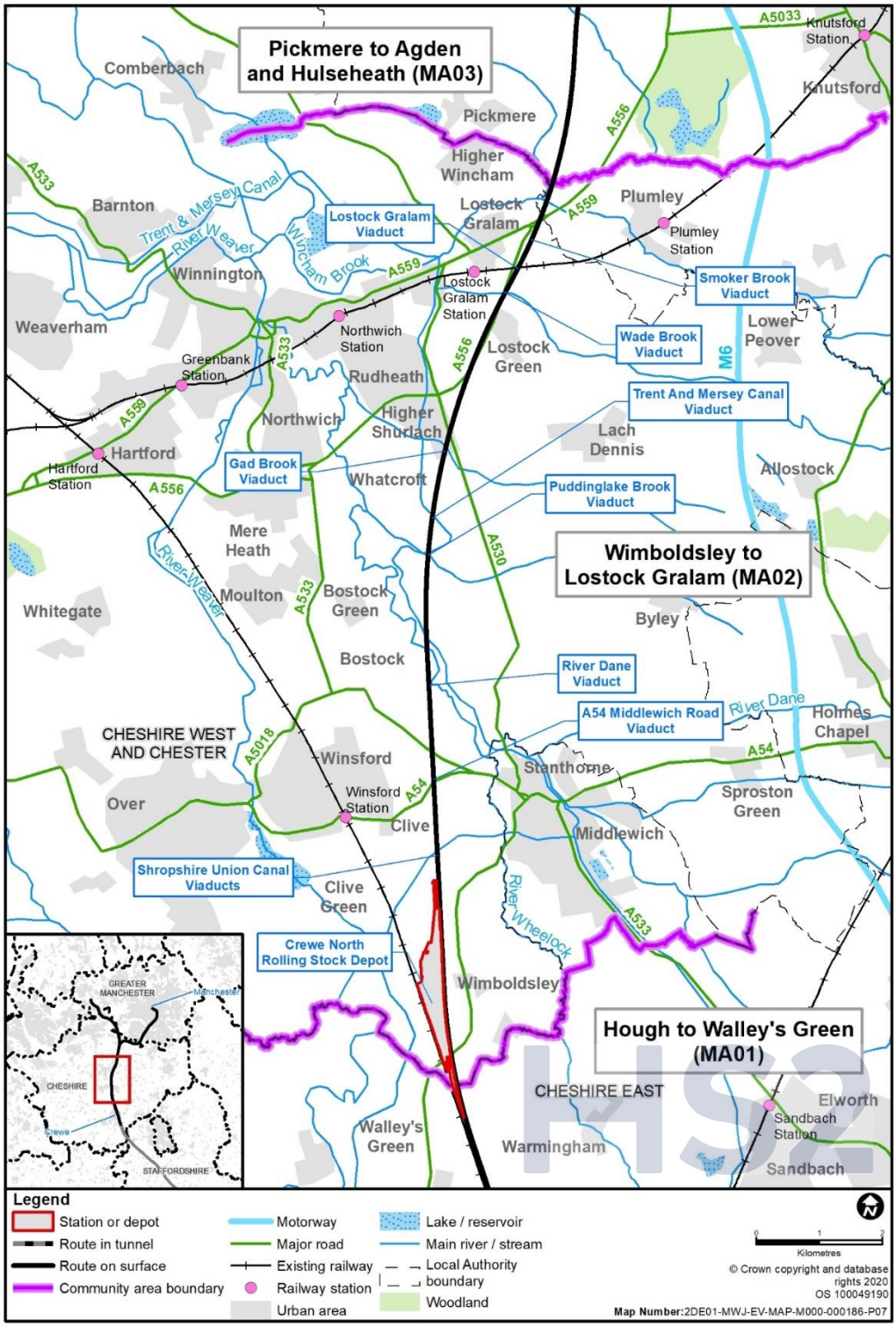

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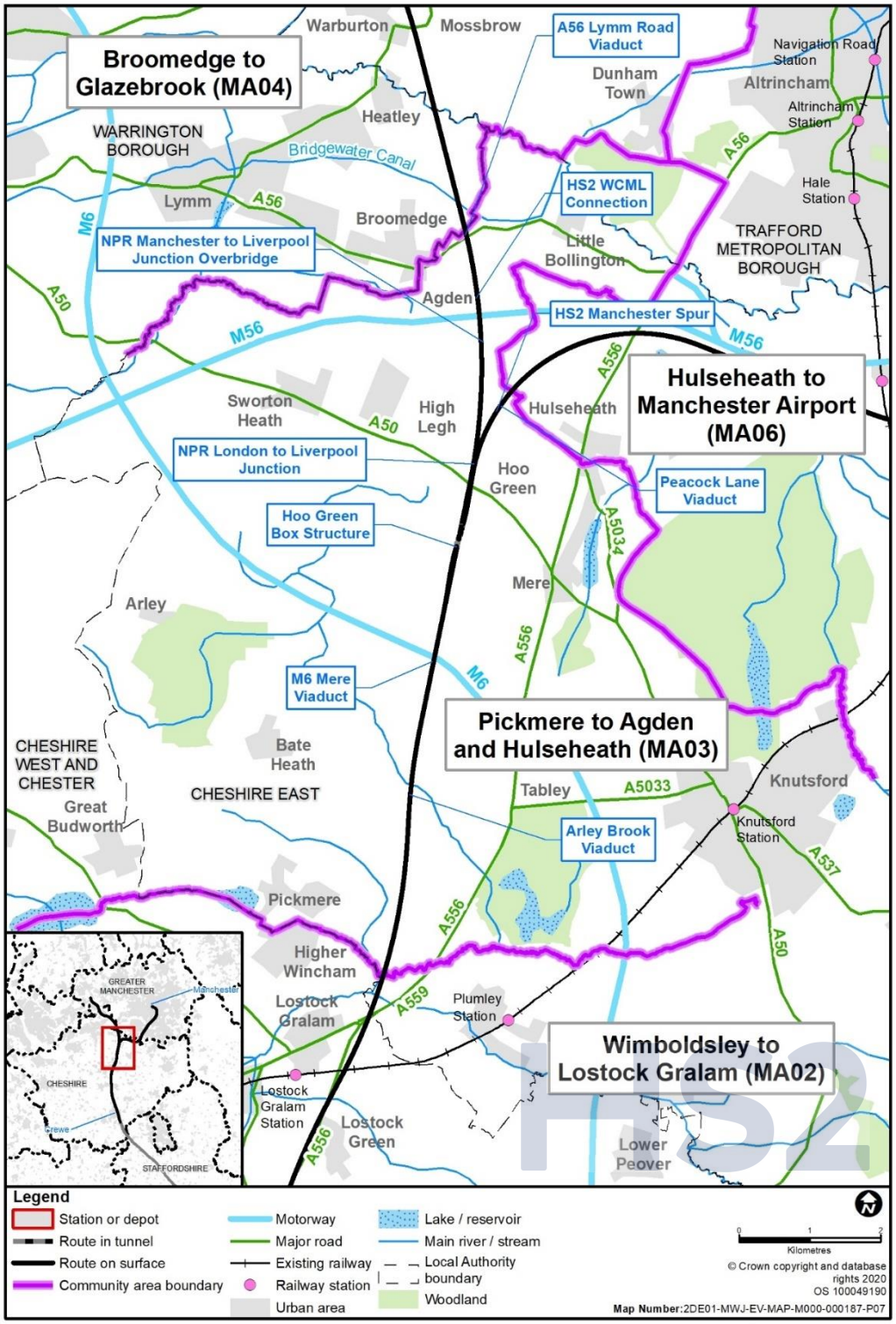

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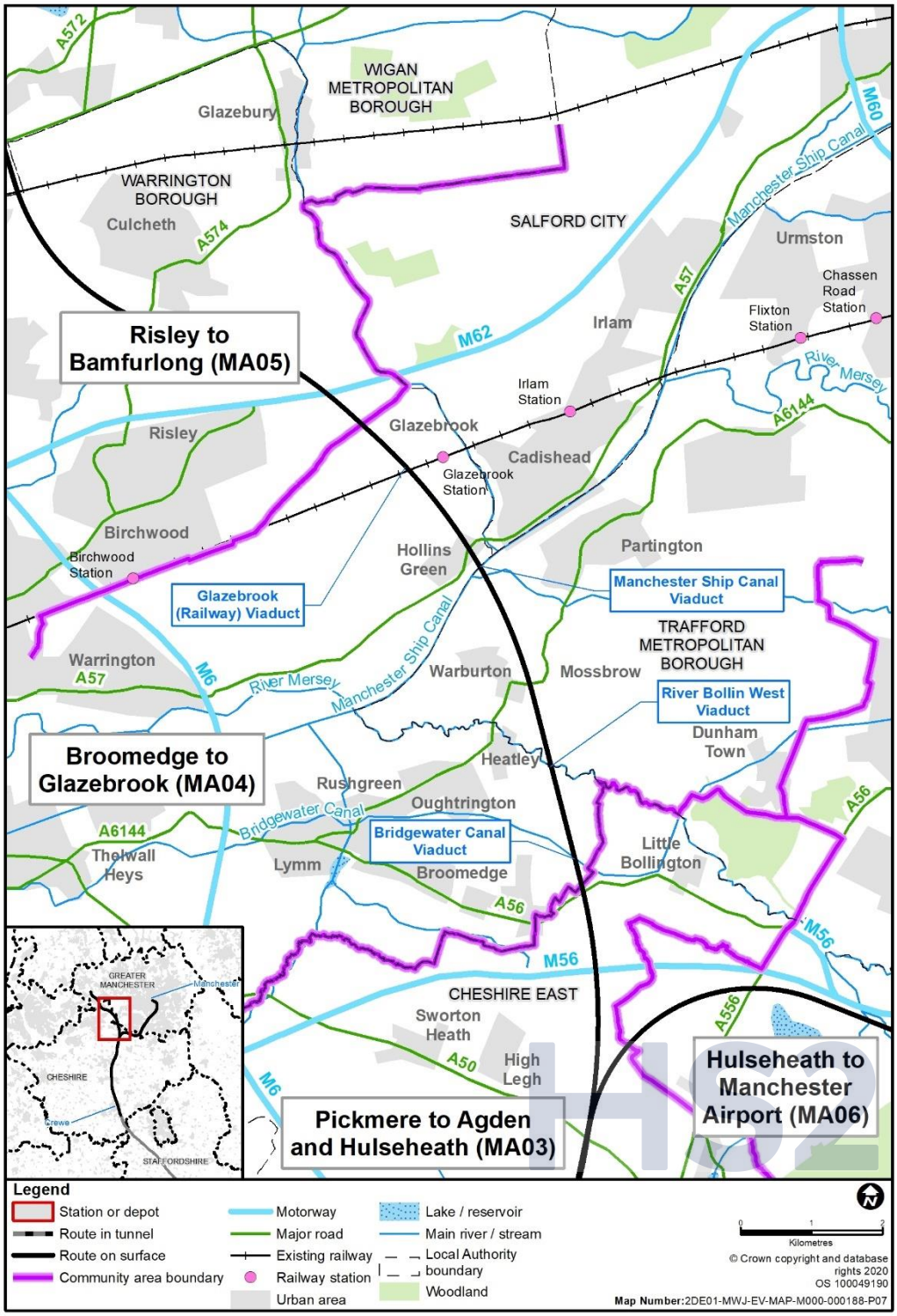

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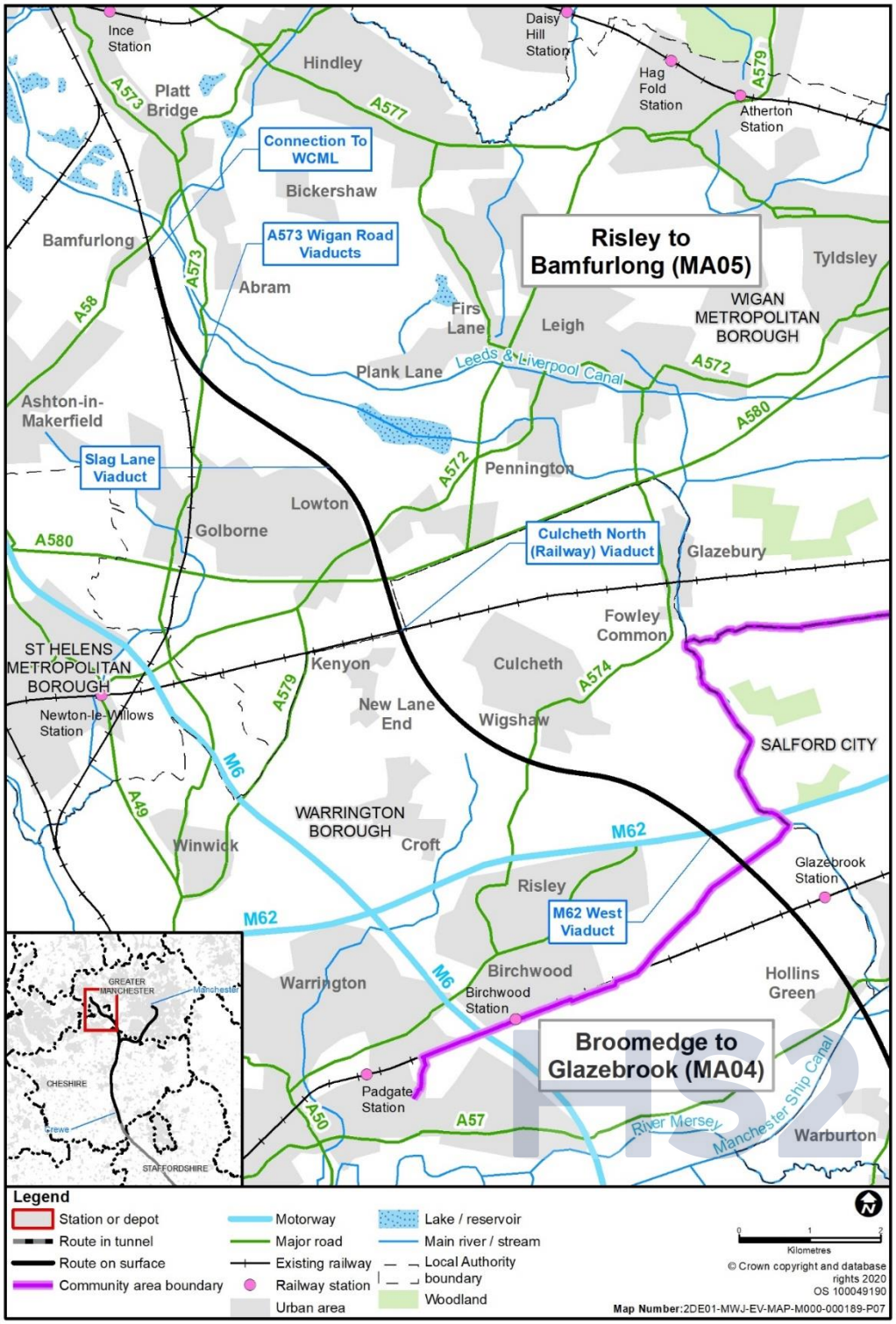

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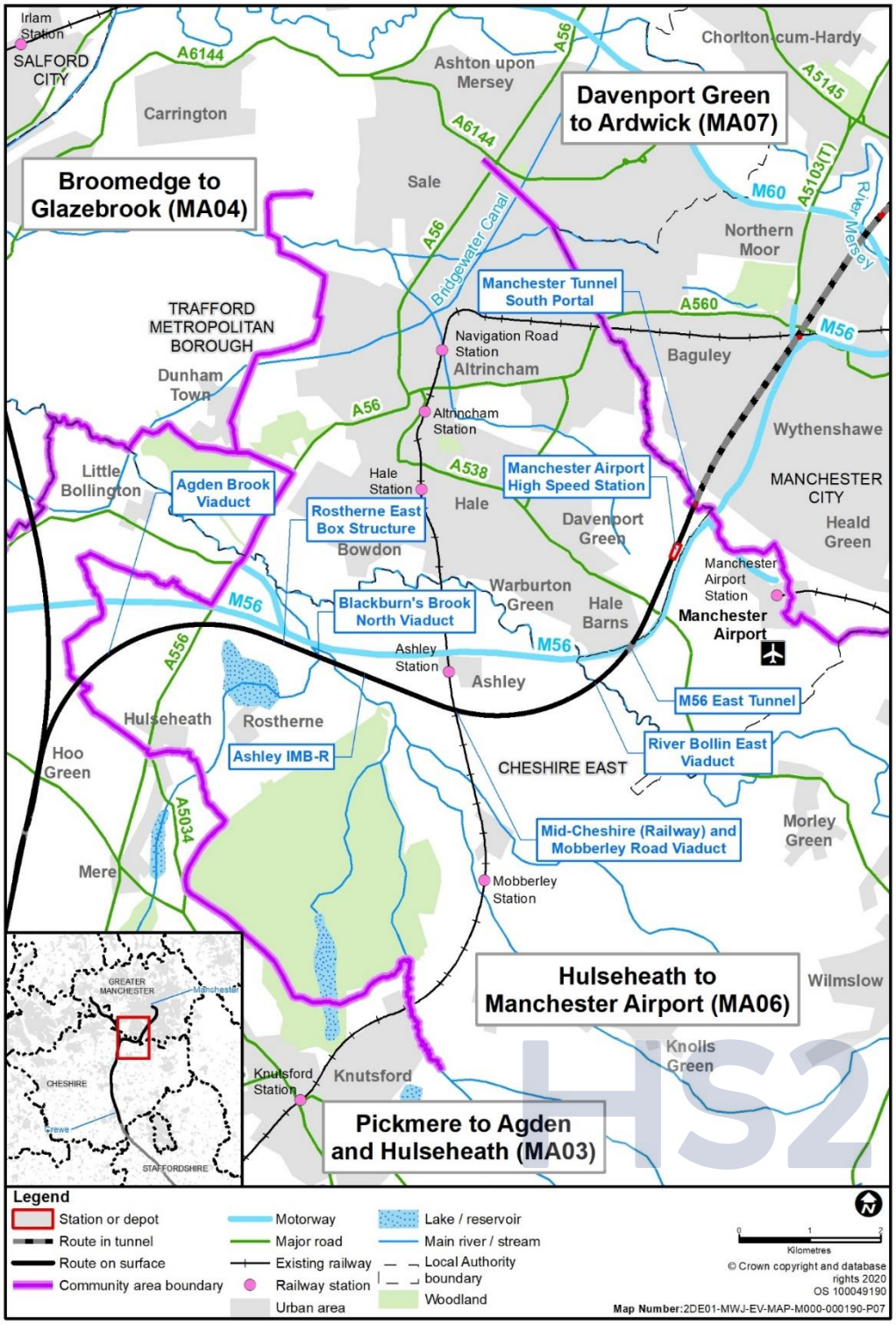

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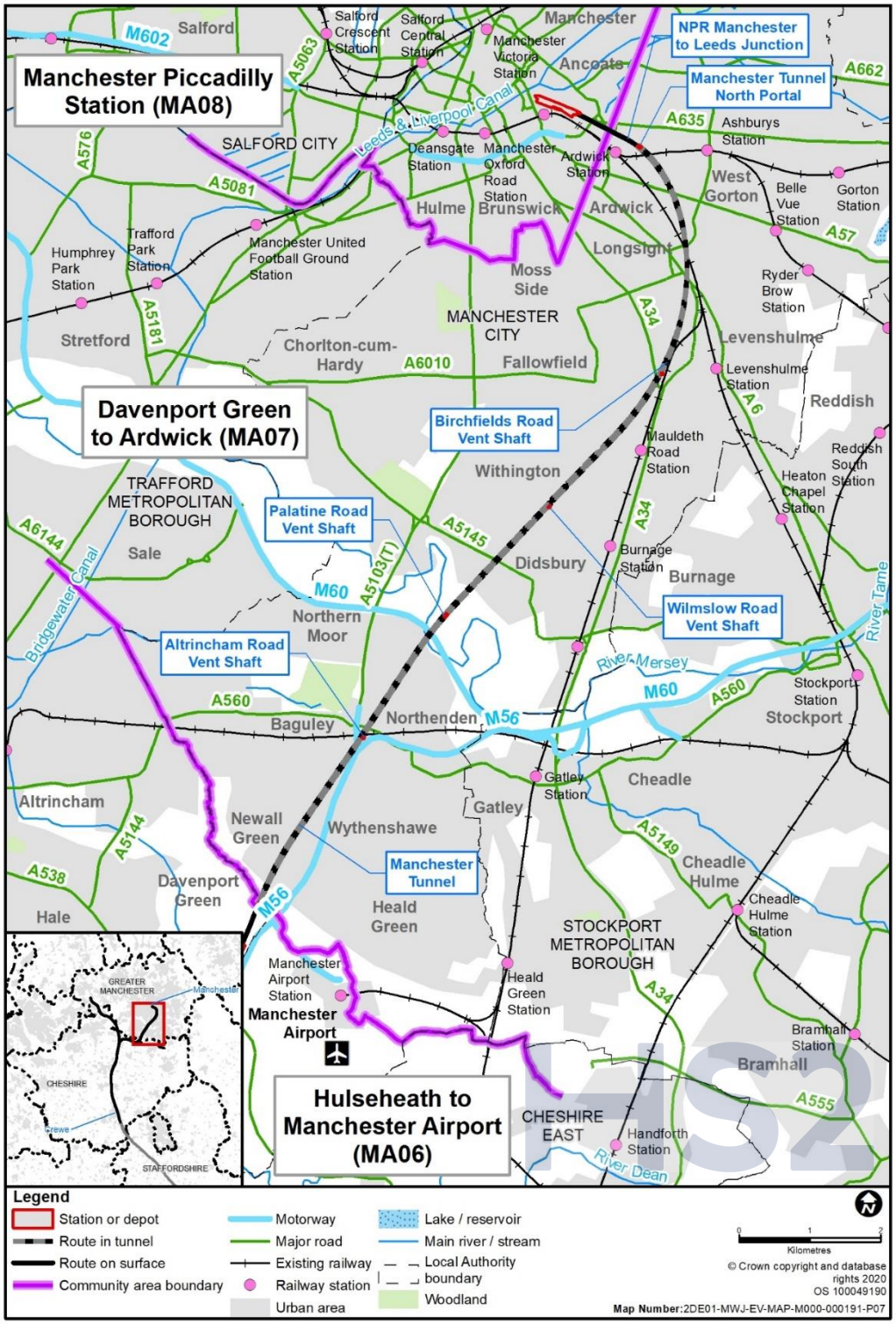

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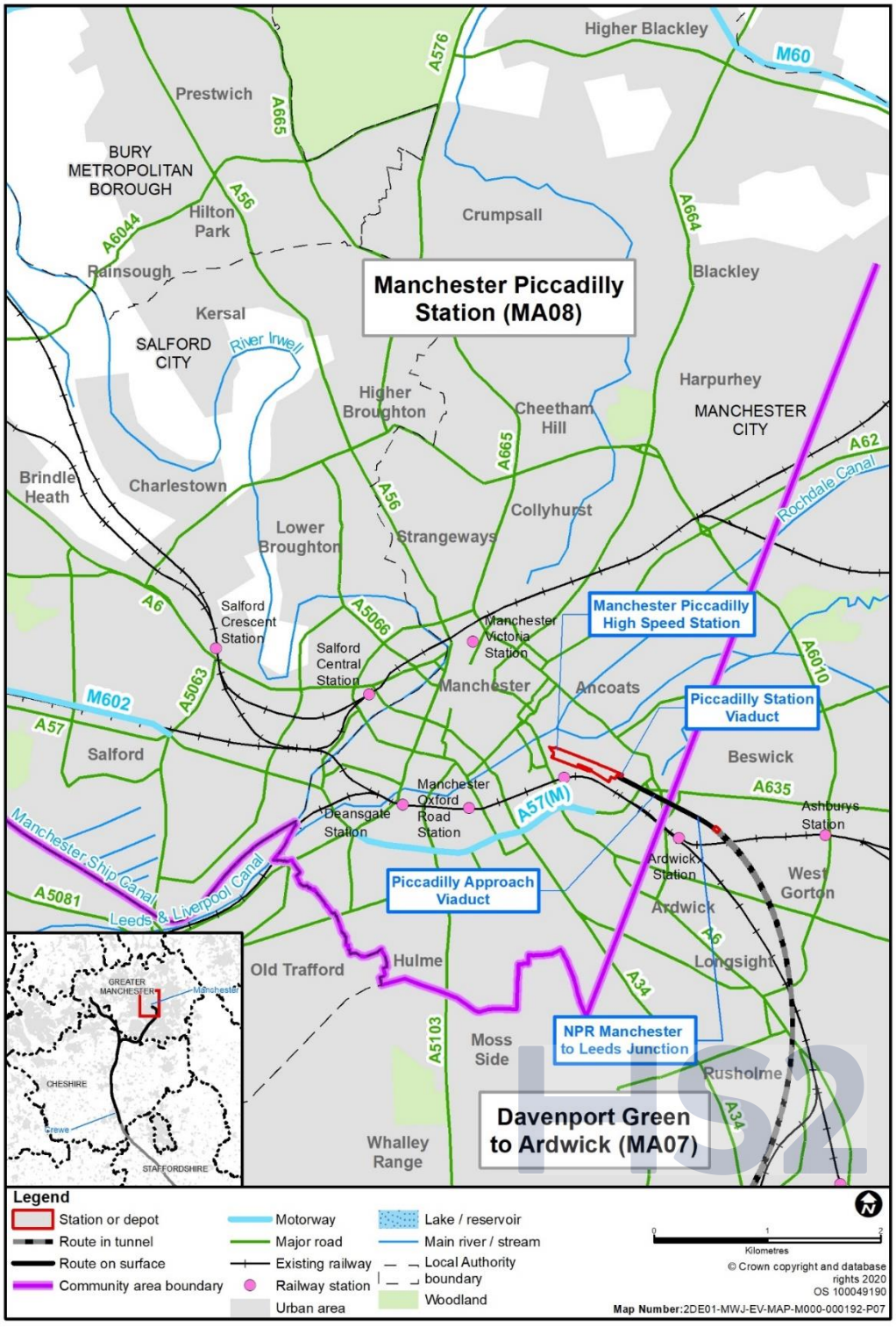

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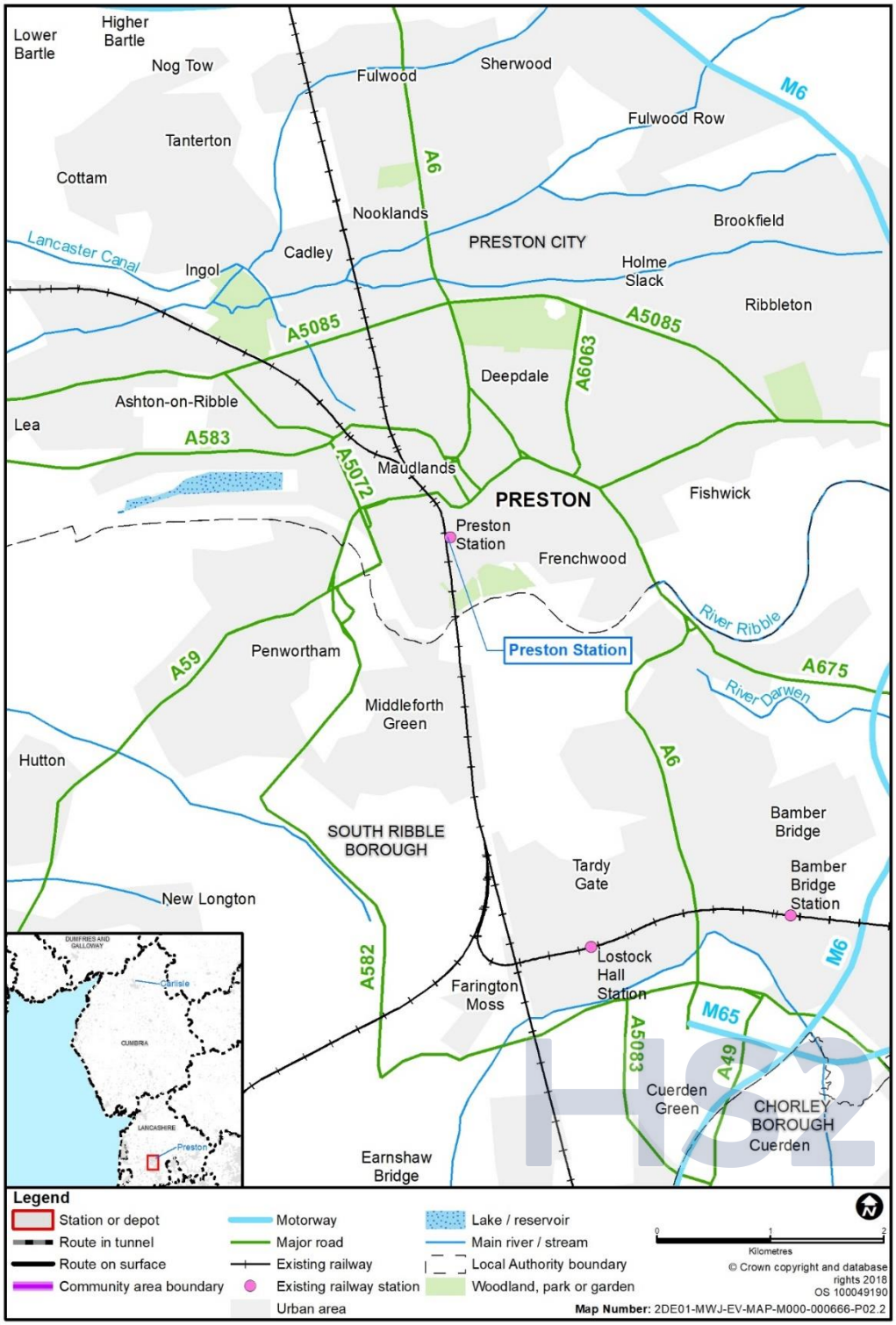

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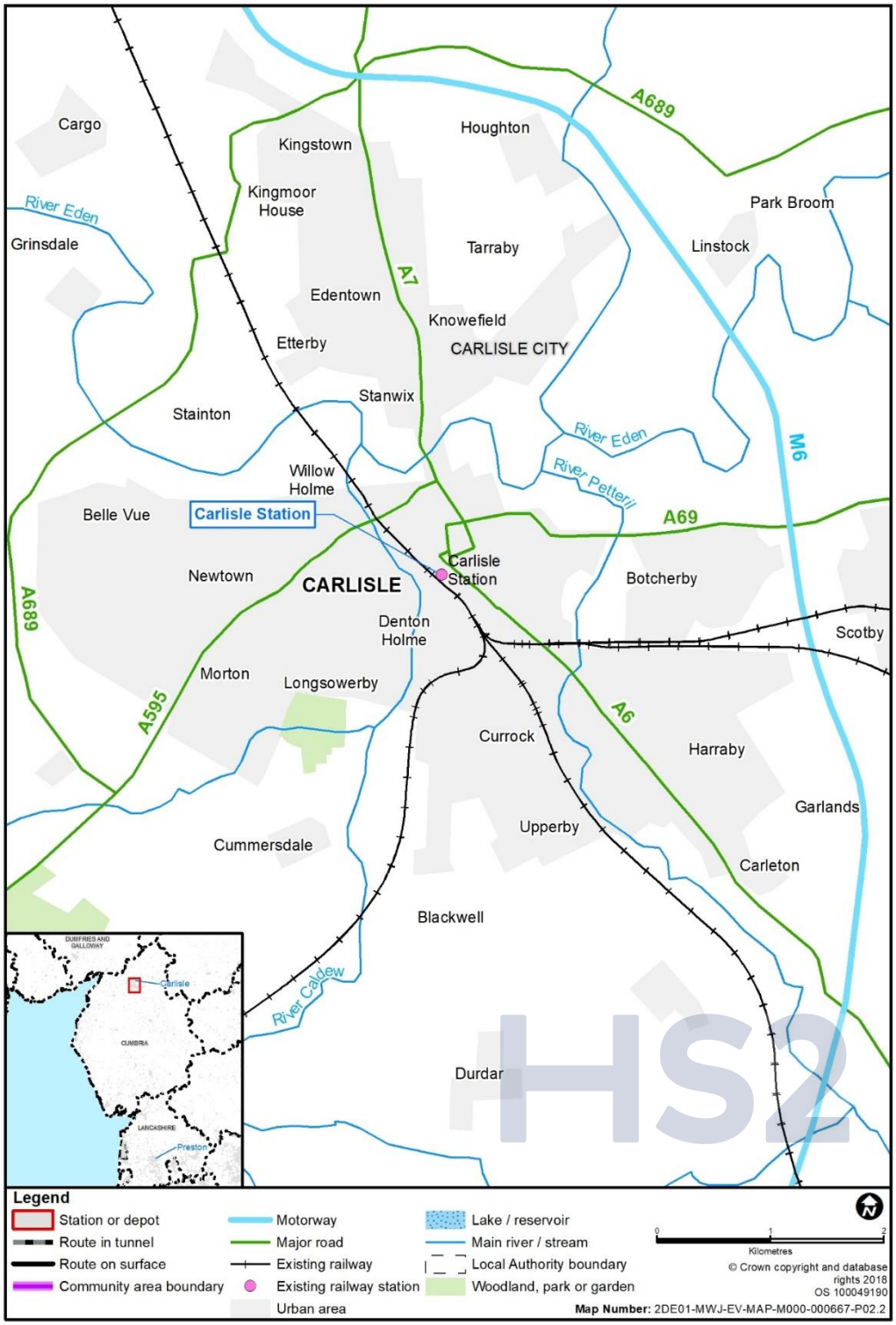

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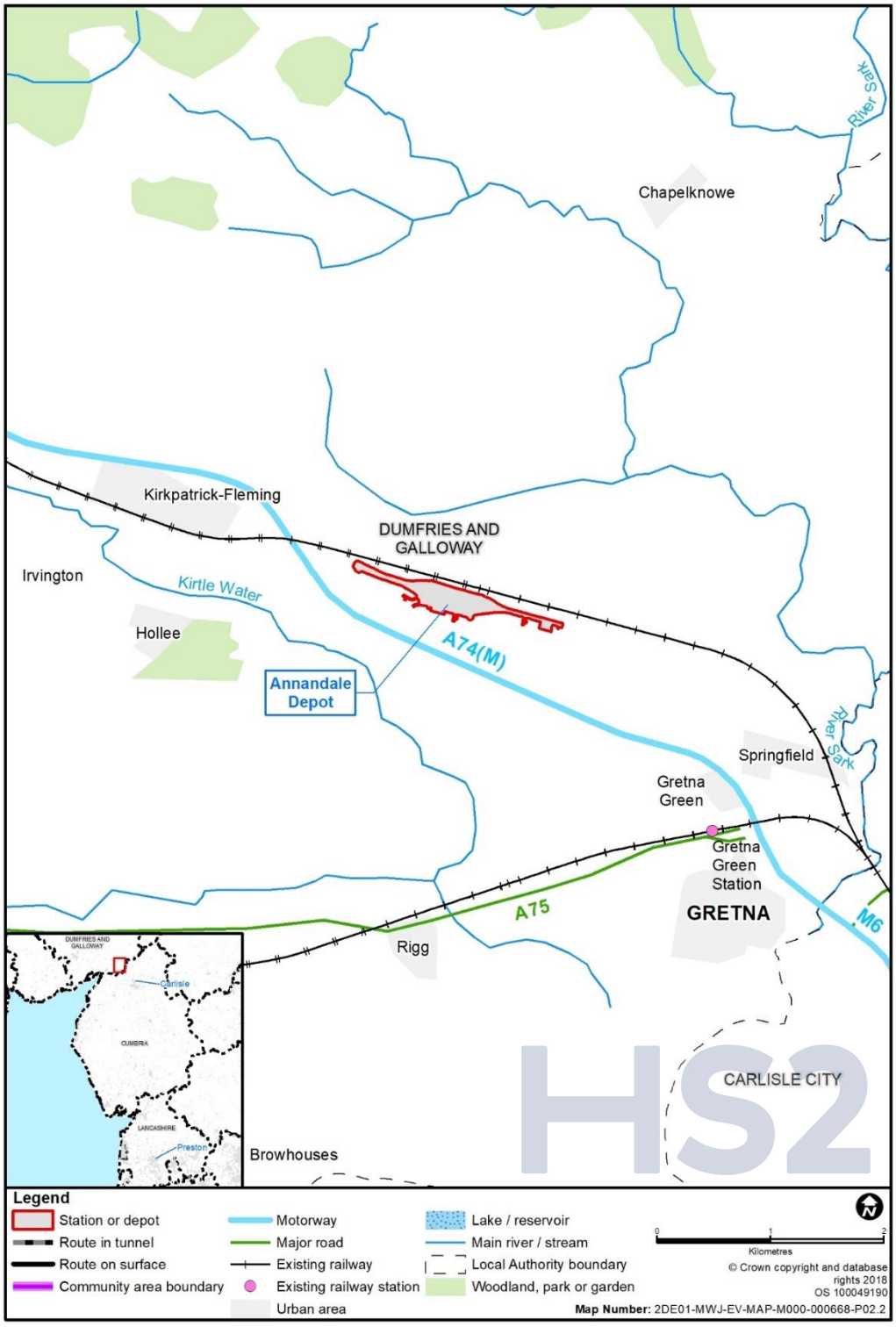


Annex C – Technical note: Air quality

The following technical note is contained in this annex:

- Air quality – Guidance on the assessment methodology.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Air quality – Guidance on the assessment methodology

Contents

1 Introduction

1.1 Purpose of the note

1.1.1 This technical note provides further information on the assessment of air quality during construction and operation of the Proposed Scheme. The Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR) provides the general methodology to be followed. This note provides a more detailed framework for assessing air quality effects during construction and operation of the Proposed Scheme.

2 General considerations

2.1 Guidance documents

2.1.1 The following guidance documents are relevant for the assessment of air quality:

- The Department for Environment, Food and Rural Affairs (Defra) Local Air Quality Management (LAQM) Technical Guidance (TG16) (February 2018) (referred to as 'Defra TG16 guidance')[1];
- Defra LAQM Policy Guidance (PG16) (April 2016) (referred to as 'Defra PG16 guidance')[2];
- Highways England Design Manual for Roads and Bridges (DMRB) LA 105 guidance (November 2019) (referred to as 'DMRB guidance')[3];
- Institute of Air Quality Management (IAQM) guidance on the assessment of dust from demolition and construction (June 2016) (referred to as 'IAQM construction dust guidance')[4];
- Greater London Authority (GLA) Supplementary Planning Guidance on the Control of Dust and Emissions during Construction and Demolition[5];
- IAQM guidance on the assessment of mineral dust impacts for planning (May 2016) (referred to as 'IAQM mineral dust guidance')[6];
- IAQM and Environmental Protection UK (EPUK) guidance on land-use planning and development control (January 2017) (referred to as 'IAQM/EPUK guidance')[7]; and
- IAQM guidance on the assessment of air quality impacts on designated nature conservation sites (May 2020) (referred to as 'IAQM ecology guidance')[8].

[1] Department for Environment, Food and Rural Affairs (2018), *Local Air Quality Management Technical Guidance (TG16).* Available online at: https://laqm.defra.gov.uk/technical-guidance/.

[2] Department for Environment, Food and Rural Affairs (2016), *Local Air Quality Management Policy Guidance (PG16).* Available online at: https://laqm.defra.gov.uk/documents/LAQM-PG16-April-16-v1.pdf.

[3] Highways England (2019), *Design Manual for Roads and Bridges (DMRB), Sustainability & Environmental Appraisal, LA 105 Air Quality.* Available online at: https://www.standardsforhighways.co.uk/dmrb/search/10191621-07df-44a3-892e-c1d5c7a28d90.

[4] Institute of Air Quality Management (2016), *Guidance on the assessment of dust from demolition and construction, v1.1.* Available online at: https://iaqm.co.uk/guidance/.

[5] Greater London Authority (2014), *Supplementary Planning Guidance, Control of Dust and Emissions during Construction and Demolition.* Available online at: https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/london-plan-guidance-and-spgs/control-dust-and.

[6] Institute of Air Quality Management (2016), *Guidance on the assessment of mineral dust impacts for planning, v1.1.* Available online at: https://iaqm.co.uk/guidance/.

[7] Institute of Air Quality Management (2017), *Land-use planning & development control: Planning for air quality, v1.2.* Available online at: https://iaqm.co.uk/guidance/.

[8] Institute of Air Quality Management (2020), *A guide to the assessment of air quality impacts on designated nature conservation sites, v1.1.* Available online at: https://iaqm.co.uk/guidance/.

2.2 Baseline data

2.2.1 Baseline monitoring data should be reported from the nearest available sites that represent the location under assessment. Where data capture is less than 90% in a year, commentary will be given on how these data may or may not reflect annual mean concentrations.

2.3 Interfaces

2.3.1 Any results that relate to receptors within an adjacent community area (CA) will be included as part of the relevant Volume 2 community area report of the Environmental Statement (ES).

2.4 Meteorological data

2.4.1 When dispersion modelling is undertaken, a sensitivity analysis will be performed using five years of hourly sequential meteorological data from a station as indicated below (depending on location). The results for the full assessment will then be presented based on 2018 meteorological data, unless the sensitivity analysis suggests that another year is likely to lead to results that would materially affect the conclusions of the assessment. The choice of any year other than 2018 will be justified.

2.4.2 Data from the meteorological station at Manchester Airport will be used in the assessment, unless there are particular local features to suggest another site is more appropriate.

2.5 Limitations

2.5.1 Non-scheme car park emissions will not be assessed unless professional judgement indicates that they may contribute significantly to the outcome and have not been included in the baseline.

2.5.2 Emissions from rail brake and track wear during operation are assumed to be negligible and will not be included in the assessment.

2.5.3 Trains and much of the Proposed Scheme infrastructure will be electrically operated. Emissions from power plants used to power the trains and infrastructure are outside the scope of a local air quality assessment and will not be included in the assessment.

3 Assessment of dust emissions

3.1 Type of assessment required

3.1.1 Emissions of dust and particulates during construction will be assessed following the IAQM construction dust guidance[4]. This section provides an interpretation of the guidance for application to the assessment of the Proposed Scheme.

3.1.2 Within the IAQM guidance, an 'impact' is described as a change in pollutant concentrations or dust deposition and an 'effect' is described as the consequence of an impact. The main impacts that may arise during construction are:

- dust deposition, resulting in soiling of surfaces;
- visible dust plumes; and
- elevated PM_{10} concentrations.

3.1.3 The IAQM guidance considers the potential for dust emissions from dust-generating activities, such as demolition of existing structures, earthworks, construction of new structures and trackout. Earthworks refer to the processes of soil stripping, ground levelling, excavation and land capping, while trackout is the transport of dust and dirt from the site onto the public road network where it may be deposited and then re-suspended by vehicles using the network. This arises when vehicles leave the site with dusty materials, which may then spill onto the road, or when they travel over muddy ground on site and then transfer dust and dirt onto the road network.

3.1.4 For each of these dust-generating activities, the guidance considers three separate effects: annoyance due to dust soiling, harm to ecological receptors and the risk of health effects due to a significant increase in PM_{10} exposure. The receptors can be human or ecological and are chosen based on their sensitivity to dust soiling and PM_{10} exposure.

3.1.5 The methodology takes into account the scale to which the above effects are likely to be generated (classed as small, medium or large), along with the levels of background PM_{10} concentrations and the distance to the closest receptor, in order to determine the sensitivity of the area. This is then taken into consideration when deriving the overall risk for the site. Suitable mitigation measures are also proposed to reduce the risk of dust emissions from the site.

3.2 Types of receptors

3.2.1 The IAQM guidance details two types of relevant receptors that will be taken into account in the assessment – human and ecological receptors.

3.2.2 A human receptor is defined as any location where a person may experience the annoyance effects of airborne dust or dust soiling, or exposure to PM_{10} over a time period relevant to the air quality standards. For the purposes of the assessment of the Proposed Scheme this is

mainly residential dwellings. The IAQM guidance also directs that some commercial premises may have a particular sensitivity to dust, however, the assessment must take into account the actual situation at premises of this type as they may already have protected their operations against increased dust levels. Some horticultural operations are also considered to be dust sensitive.

3.2.3 An ecological receptor is any habitat that may be sensitive to dust soiling from direct impacts (e.g. excessive dust deposition) or indirect impacts on fauna (foraging habitats).

3.3 Spatial scope of assessment

3.3.1 The IAQM guidance suggests that an assessment is required where there are sensitive receptors within 350m of the boundary of the site (or 50m for ecological receptors), within 50m of the route used by construction vehicles on the public highway and up to 500m from the site entrance. It is acknowledged in the guidance that these values are conservative and hence there is scope for specific criteria to be applied at certain locations if required.

3.4 Temporal considerations

3.4.1 The assessment of impacts will consider the construction activities throughout the construction period. However, a separate assessment will not be undertaken for every year throughout construction at every site. The assessment will instead capture the periods where the risks of adverse impacts are at their highest.

3.4.2 The assessment of each major construction activity will therefore draw upon the construction programme to identify the duration and location of activities that would give rise to air quality impacts. As the IAQM guidance provides a three-scale level of risk for various activities that depends on their scale and distances to sensitive receptors, it is likely that the overall risk will change at different times during the construction period.

3.4.3 The assessment will therefore identify any changes in the risk of adverse effects through the construction period and set out an appropriate level of mitigation to reduce those risks. The level of mitigation proposed will be consistent with that proposed in the IAQM guidance document and detailed within the draft Code of Construction Practice (CoCP).

3.5 Mitigation measures

3.5.1 When undertaking the construction impact assessment, the mitigation measures detailed within the draft CoCP will be applied. The assessment will also take into consideration any policies and commitments made by HS2 Ltd.

3.5.2 The IAQM guidance notes that with the application of sufficient mitigation measures, no significant effects would be anticipated from construction activities. Should further mitigation measures be necessary at certain locations, these will be formulated taking into consideration the measures detailed in the IAQM guidance and best practice.

4 Assessment of mineral dust emissions

4.1 Type of assessment required

4.1.1 Emissions of dust and particulates from mineral extraction operations during construction will be assessed following the relevant IAQM mineral dust guidance. This section provides an interpretation of the guidance for application to the assessment of the Proposed Scheme.

4.1.2 Dust arising from mineral extraction operations can be distinguished between coarser particles that can reduce amenity in the local community due to visible dust plumes and dust soiling ('disamenity dust') and smaller particles that can increase local pollutant concentrations (PM_{10} and $PM_{2.5}$) which is associated with a range of health effects.

4.1.3 Within the IAQM mineral dust guidance, an 'impact' is described as a change in suspended particulate matter concentration or dust deposition and an 'effect' is described as the consequence of an impact to human health or disamenity. The main impacts that may arise during mineral activities are:

- dust accumulation, resulting in soiling of surfaces and disamenity;
- visible dust plumes; and
- elevated concentrations of particulate matter.

4.1.4 The IAQM mineral dust guidance considers the potential for emissions from dust-generating activities, such as preparation of the land, extraction, processing, handling and transportation of extracted material.

4.1.5 The assessment will be undertaken using the source-pathway-receptor approach described in the IAQM mineral dust guidance. This is a concept whereby a hypothetical relationship is applied between the source of the pollutant, the pathway by which exposure may occur and the receptor that could be adversely affected.

4.1.6 The methodology takes into account the effectiveness of the pathway and the scale of the source to derive the risk of dust impacts at individual receptors. This is then combined with the sensitivity of each receptor to derive the likely magnitude of the effect that will be experienced. Consideration is then given to the overall effects from dust deposition from each mineral extraction site.

4.1.7 For the assessment of suspended particulate matter, consideration needs to be given to the existing background PM_{10} concentrations in the area. The process contribution from the mineral extraction activities is then estimated at each receptor and an overall PM_{10} impact for the area is derived.

4.2 Types of receptors

4.2.1 The IAQM guidance details two types of relevant receptors that will be taken into account in the assessment – human and ecological receptors. A human receptor is defined as any location where a person may experience the disamenity effects of dust or the health effects from exposure to PM_{10} over a time period relevant to the air quality standards. For the purposes of the assessment of the Proposed Scheme this is mainly residential dwellings. An ecological receptor is any habitat that may be sensitive to dust deposition from direct impacts on vegetation or aquatic ecosystem or indirect impacts on fauna.

4.3 Spatial and temporal scope of assessment

4.3.1 The IAQM guidance suggests where there are sensitive receptors within 1km of dust generating activities, an assessment of PM_{10} concentrations will be required. Where there are sensitive receptors within 250m (soft rock) or 400m (hard rock) of extraction activities, an assessment of disamenity dust will be required.

4.3.2 The assessment of impacts will consider the mineral extraction operations throughout the construction period. It will identify the risk of adverse effects during the construction period and set out an appropriate level of mitigation to reduce those risks. The level of mitigation proposed will be consistent with that proposed in the IAQM mineral dust guidance and has been detailed within the draft CoCP.

4.4 Mitigation measures

4.4.1 When undertaking the assessment of mineral dust impacts the mitigation measures detailed within the draft CoCP will be applied. The assessment will also take into consideration any policies and commitments made by HS2 Ltd. Should further mitigation measures be necessary at certain locations, these will be formulated taking into consideration the measures detailed in the IAQM mineral dust guidance and best practice.

5 Assessment of vehicle emissions

5.1 Type of assessment required

5.1.1 Traffic data will be screened using the following criteria taken from the current and previous DMRB guidance to identify where further assessment is required. These criteria are the following:

- change in road alignment by 5m or more;
- change in daily traffic flows by 1,000 vehicles or more as annual average daily traffic (AADT);
- change in daily flows of heavy goods vehicles (HGVs) by 200 AADT or more;
- change in daily average speed by 10kph or more; or
- change in peak hour speed by 20kph or more.

5.1.2 The screened in roads will then be included in an atmospheric dispersion model for detailed assessment.

5.1.3 Consideration will also be given as to whether other roads that would be screened out using the above criteria are to be included in the assessment. An example of this is roundabout links and slip roads along dual carriageway road links that have been screened in.

5.2 Types of receptors

5.2.1 Human receptors to be included in the air quality assessment of vehicle emissions will be taken from the Ordnance Survey (OS) AddressBase Plus database. These will be screened for sensitivity to air quality following the Defra TG16 guidance.

5.2.2 Ecological receptors to be included in the air quality assessment will be those national or international designated sites with habitats sensitive to NOx deposition. These could include Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), National Nature Reserves (NNR), Special Protection Areas (SPA) or Ramsar sites.

5.2.3 Receptors will be chosen so the worst affected relevant sensitive exposure (residential properties, schools, hospitals, nursing homes) on each road and at each junction on the assessed road network is represented. If several receptors are present at a junction and it is unclear which of them would be the worst affected receptor, all of the potential worst affected receptors will be modelled. Where there is no sensitive exposure at junctions, receptors will be chosen alongside the screened in roads so that all possible worst case effect locations are represented.

5.2.4 For assessment of car parks, receptors will be chosen near the perimeter of the car park where worst case effects are likely, considering contributions from other modelled sources (car parks and roads). Additionally, receptors included in any combustion plant assessment will be included in the model runs to account for cumulative effects.

5.2.5 All sensitive human receptors will be modelled at a height of 1.5m and at the façade closest to the modelled roads. For ecological receptors, transects will be used from the edge of the road towards the ecological site, with modelled points at 0m, 10m, 20m, 30m, 40m, 50m, 75m, 100m, 150m and 200m from the road. All ecological receptors will be modelled at ground level, i.e. height of 0m.

5.3 Spatial scope of assessment

5.3.1 Any quantitative air quality assessment will cover the roads which meet the screening criteria and roads which adjoin them to enable the effects at junctions to be assessed.

5.4 Scenario nomenclature

5.4.1 The following scenarios will be assessed:

- 2018 current baseline (for model verification, if required);
- selected year(s) within the construction period for the assessment of the effects of construction. The year(s) of assessment will be selected based on the worse case peak period during the construction programme and on when significant effects might be expected; and
- an operational scenario will be assessed for the first full operational year after construction is completed.

5.4.2 For each assessment year, the scenario without the Proposed Scheme in place and the scenario with the Proposed Scheme in place will both be assessed.

5.5 Modelled pollutants, model version and emission factors

5.5.1 Only annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations are required to be modelled (and NOx for ecological receptors). The treatment of short-term statistics is explained in the following paragraphs.

5.5.2 NOx output from the models for both on road sources and car parks will be combined with the background NOx and NO_2 concentrations in the Defra NOx to NO_2 conversion spreadsheet[9] to obtain total roadside and background annual mean NO_2 concentrations. Modelled combustion plant NO_2 contributions will be added to these values to yield a total annual mean NO_2 concentration.

5.5.3 The predicted number of exceedances of the 1-hour NO_2 objective only be reported if the annual mean NO_2 concentrations are over 60µg/m^3. Therefore, this less onerous statistic is

[9] Department for Environment, Food and Rural Affairs (2020), *NOx to NO2 calculator.* Available online at: http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc.

not likely to be reported, unless there is a very short term activity being examined where high peaks in NO_2 concentrations are expected.

5.5.4 To calculate the annual mean PM_{10} (or $PM_{2.5}$) concentrations, the background PM_{10} (or $PM_{2.5}$) concentrations will be added to the roadside concentration output (and any modelled combustion plant output) from the model.

5.5.5 The number of exceedances of the 24-hour PM_{10} objective will be calculated using the formula in the Defra TG16 guidance, that is: No. 24-hour mean exceedances = -18.5 + 0.00145 × annual mean^3 + (206/annual mean).

5.5.6 The most recent versions of ADMS-Roads and ADMS will be used for any dispersion modelling assessment. Emissions suitable for use in the ADMS-Roads model will be generated using the most recent Emission Factors Toolkit (EFT)[10] available at the start of the assessment. For the opening year scenario, emissions will be calculated using a tool created for the project which takes into account fleet composition predictions from the National Atmospheric Emissions Inventory (NAEI) and emission factors from the EFT to calculate emissions for years post-2035.

5.5.7 The assessment will also incorporate HS2 Ltd's vehicle emissions requirements which are detailed in HS2 Phase 2a Information Paper E14 'Air Quality'. These include the use of Euro 4 petrol and Euro 6 diesel LGV, and Euro VI HGV as a minimum.

5.5.8 Emission factors for heavy vehicles using the site haul routes, such as 20t HGV and 40t articulated dump trucks (ADT), will be taken from the NAEI.

5.6 ADMS model parameters

5.6.1 ADMS-Roads meteorological setting will remain as default, except for the surface roughness and minimum Monin-Obukhov length[11] – advice on the relevant values to be used will be taken from the ADMS-Roads manual[12] based on the characteristics of the study area as shown in Table 1.

5.6.2 For the meteorological site, the surface roughness will be selected as representative of the meteorological station location and no minimum Monin-Obukhov length will be selected.

5.6.3 Terrain will not be included in dispersion modelling unless justified using professional judgement.

[10] Department for Environment, Food and Rural Affairs (2020), *Emissions Factor Toolkit.* Available online at: https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html.

[11] The minimum Monin-Obukhov length is a parameter describing the stability of the atmosphere.

[12] Cambridge Environmental Research Consultants (2020), *ADMS Roads User Guide v5.0.*

Table 1: Surface roughness values for ADMS

Study area	Surface roughness (m)
Large urban areas	1.5
Cities / woodlands	1.0
Parkland, open suburbia	0.5
Agricultural areas (max)	0.3
Agricultural areas (min)	0.2
Root crops	0.1
Open grassland	0.02
Short grass	0.005

5.7 Car parks, stationary idling vehicles

5.7.1 Emissions from car parks will be assessed using ADMS-Roads. These will include new car parks for the operation of the Proposed Scheme and any car parks introduced during construction if operational for over nine months. Emissions from movements within the car park will be estimated using the EFT spreadsheet. The travel speed will be set at 5kph and the travel distance within the car park will be set to the car park perimeter for surface car parks with half the perimeter distance added for each floor above ground level for multi-storey car parks.

5.7.2 Consideration will be given to the inclusion of places where vehicles may stand with engines idling e.g. taxi stands (use design length of taxi ranks, number of vehicles, duration of stay etc.) and pick-up and drop-off areas. Emissions will be calculated using the latest EFT version and the methodology described in the TG16 guidance. Cold start emissions from car parks will also be calculated using emission factors from the NAEI[13] and distributed within the car park area.

5.7.3 Car parks will be modelled as area sources at ground level for surface cars parks, as volume sources using the height of the car park for multi-storey car parks, or as point sources at ventilation points for mechanically ventilated underground car parks (or at the entrance or openings of the car park if not mechanically ventilated), using emissions calculated for cold start and internal movement emissions uniformly distributed throughout the sources.

5.8 Background concentrations

5.8.1 Data for background concentrations will be taken from the latest maps available on the Defra website[14] and from local monitoring information available in the area. Professional

[13] National Atmospheric Emissions Inventory. Available online at: https://naei.beis.gov.uk/data/ef-transport.

[14] Department for Environment, Food and Rural Affairs, *Background maps.* Available online at: https://uk-air.defra.gov.uk/data/laqm-background-home.

judgment will be used to determine which data is most appropriate to be used for the assessment of each area.

5.8.2 If local monitoring data is not available for the base year of 2018, it will be adjusted using the same factors for the area as those used in the Defra background maps. Local background monitoring data will also be adjusted, if used, for the required assessment years.

5.8.3 Background NOx and NO_2 concentrations will be sector-removed using the Defra tool. No sector-removal will be undertaken for PM_{10} and $PM_{2.5}$ concentrations.

5.9 Speeds

5.9.1 Where data exist on actual speeds these will be used. In the absence of actual or modelling traffic speed data, the following speeds will be used (unless justified otherwise):

- speed limit; and
- junctions and roundabouts = 20kph.

5.10 Model verification

5.10.1 An existing baseline year of traffic data will be used for the study area (i.e. 2018 current baseline scenario). A full assessment of the entire study area will not be required; however, this information will be used to test model performance and undertake model verification.

5.10.2 The model will be verified at selected suitable continuous and/or diffusion tube NO_2 monitoring sites in accordance with the Defra TG16 guidance. Kerbside sites will not be included in the model verification exercise. Adjustment to the model using the procedure detailed in the Defra TG16 guidance will be made if the average difference between modelled and monitored NO_2 concentrations exceeds 25% of monitored concentrations or if there is a consistent under or over prediction.

5.10.3 Where monitoring of NO_2 concentrations is undertaken for the Proposed Scheme, the analysis of the data (including annualisation and/or bias adjustment) will follow the Defra TG16 guidance.

5.10.4 Predicted PM_{10} and $PM_{2.5}$ concentrations will not be adjusted.

6 Combustion plant assessment

6.1 Type of assessment required

6.1.1 Emissions from any buildings will be considered in the assessment. Professional judgement will be used to determine the most appropriate method for assessment which will be qualitative or quantitative, including dispersion modelling. This should include consideration of the criteria for assessment included in the IAQM/EPUK guidance.

6.1.2 Where relevant, professional judgement and/or dispersion modelling will be used to suggest design modifications including height and location of flues/stacks, particularly in relation to any adjacent or neighbouring buildings or structures.

6.1.3 Professional judgement will be used as to whether modelling of plant that is not used throughout the year is appropriate (e.g. back-up generators run only for testing other than in the event of power failure).

6.1.4 Dispersion modelling will be undertaken with the atmospheric dispersion model ADMS and/or ADMS-Roads, using the most up to date version as of the date of receipt of the model input data.

6.2 Pollutants emissions and model inputs

6.2.1 The modelling assessment will consider annual mean NOx emissions for gas fired plant and NOx, PM_{10} and $PM_{2.5}$ emissions for other fired plant.

6.2.2 Inputs to the model will be derived from the boiler size and fuel type, using the boiler specifications if available.

6.2.3 Only annual mean concentrations will require modelling. NO_2 concentrations will be assumed to be 100% of NOx predicted concentrations as detailed in the Defra and Environment Agency guidance on air emissions risk assessment[15]. The handling of short term statistics is explained in Section 5.5 of this technical note.

6.3 Types of receptors

6.3.1 Receptors will be selected based on either their proximity to the source or as the likely most affected receptors. Receptors will include all locations where people might reasonably be (including residential, hotels, nurseries, hospitals, schools, nursing home buildings) and/or

[15] Department for Environment, Food and Rural Affairs and Environment Agency (2020), *Air emissions risk assessment for your environmental permit.* Available online at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit.

ecological receptors if considered sensitive to the pollutant being considered and present on a nationally or internationally designated site.

6.3.2 If receptors are present in several directions from the stack, the closest receptor in each direction will be selected. The height above ground of the receptors will be set to the height of opening windows and/or air intakes most similar in height to the stack height. Nearby receptors included in any quantitative road and car park assessment will be included in the model runs to account for cumulative effects.

6.3.3 Receptors will all be set at local ground level and also at various heights above ground if relevant. Consideration will be given in urban areas where there are many receptors at heights more than two metres above ground to modelling a series of grids at various heights (in order to ensure that exposure of receptors at height are considered).

7 Assessment of rail emissions

7.1 Type of assessment required

7.1.1 An assessment of emissions from diesel locomotives will be undertaken following the Defra TG16 guidance.

7.2 Pollutants emissions

7.2.1 The assessment will take into account both stationary and moving locomotives. The criteria detailed in the Defra TG16 guidance will be used for the assessment of NO_2 and/or sulphur dioxide (SO_2) concentrations. These are:

- locations where sensitive receptors are within 15m from sites that locomotives remain stationary for periods of 15 minutes or more, at least 3 times a day; and
- locations where sensitive receptors are within 30m of the railway track and background annual mean NO_2 concentrations are above 25µg/m^3.

7.2.2 Where these criteria are met, it will be concluded that there is a risk of exceedance of the air quality standards and mitigation measures will be proposed.

8 Assessment of significance

8.1 Type of assessment required

8.1.1 The significance of effects resulting from the Proposed Scheme on local air quality from vehicle and/or combustion plant emissions will be assessed using the framework described in this section.

8.2 Describing the impacts

8.2.1 Predicted annual mean pollutant concentrations will be compared between the 'with' and 'without' Proposed Scheme assessment scenarios. The predicted change in concentrations will be used along with the predicted concentrations from the 'with the Proposed Scheme' scenario to assess local air quality impacts at individual receptors. The impact descriptors are shown in Table 2, taken from the IAQM/EPUK guidance. Changes in pollutant concentrations less than 0.5% of the air quality standard will be described as 'negligible'.

8.2.2 Where an increase in concentrations has been predicted with the Proposed Scheme, the resulting impact will be described as 'adverse'. Where a decrease in concentrations has been predicted with the Proposed Scheme, the resulting impact will be described as 'beneficial'.

Table 2: Impact descriptors for individual receptors (adapted from the IAQM/EPUK guidance)

Predicted annual mean concentration in relation to standard	Percent change in concentrations as a result of the Proposed Scheme in relation to standard			
	1%	2 – 5%	6 – 10%	> 10%
< 75%	Negligible	Negligible	Slight	Moderate
76 – 94%	Negligible	Slight	Moderate	Moderate
95 – 102%	Slight	Moderate	Moderate	Substantial
103 – 109%	Moderate	Moderate	Substantial	Substantial
> 110%	Moderate	Substantial	Substantial	Substantial

8.3 Significance of effects

8.3.1 The approach used to assess significance described in the EPUK/IAQM guidance is designed to be a measure of the significance of the changes in air quality in terms of compliance with air quality standards and is not intended to be an assessment of any potential health impacts. That is to say, a significant air quality impact determined on the basis of the IAQM/EPUK approach would not necessarily, or usually, denote a significant health impact. However, the assessment method is intended to provide information on changes in pollutant concentrations that can be used to assess health effects, by flagging up locations and impacts which may merit further consideration.

8.3.2 Receptors predicted to experience negligible or slight impacts will be described as having no significant air quality effects. Receptors predicted to experience moderate or substantial impacts will be described as having significant air quality effects.

8.3.3 For ecological receptors, if the predicted change in nitrogen deposition is greater than 1% of the lower critical load for the site, then there is a risk of significant effects. In such cases, the judgement of significance will be undertaken by Ecology specialists and reported within the ecology assessment.

9 Route-wide modal shift assessment

9.1.1 A route-wide air quality assessment will be undertaken for changes brought about by passenger modal shift from the operation of the Proposed Scheme. This relates to moving passengers from road to rail and cutting emissions in the process.

9.1.2 NOx, PM_{10} and $PM_{2.5}$ emissions will be calculated for changes in vehicle kilometres from accessing long distance rail and highway local trips. Information on fleet composition will be used to separately calculate emissions from petrol, diesel and electric cars. Emission factors will be taken from the Defra EFT and the NAEI. The assessment will include changes in emissions for every year from opening until 2050.

Annex D – Technical note: Community

The following technical note is contained in this annex:

- Community – Community assessment guidance.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Community – Community assessment guidance

Contents

Tables

1 Introduction

1.1 Introduction

1.1.1 This technical note provides further guidance on the assessment methodology for assessing potential community impacts and effects considered likely to arise from the construction and operation of the Proposed Scheme. It provides further guidance on the method and approach set out within Section 9 (Community) of the Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR).

1.1.2 The technical note builds upon and updates the guidance set out within Section 9 (Community) of the HS2 Phase 2a Scope and Methodology Report (July 2017).

1.2 Community

1.2.1 Community effects are defined as non-economic effects upon people and organisations operating community facilities and will be considered against four principal types of infrastructure:

- residential property;
- community infrastructure;
- recreation infrastructure; and
- open and play space.

1.3 Other environmental impacts

1.3.1 There are a number of other environmental topics, such as Air quality, Sound, noise and vibration, Landscape and visual and Traffic and transport that inform the community assessments. An understanding of these methodologies and environmental topics will be required to give context for potential in combination effects arising from impacts related to these environmental topics.

1.4 Structure of this technical note

1.4.1 This technical note is structured as follows:

- Section 2 provides core definitions for the receptors and resources which are relevant in assessing potential community effects;
- Section 3 sets out further details of the community assessment criteria and guidance on how this will be applied; and
- Section 4 provides a list of assumptions which will be applied to the community assessment.

2 Receptor and resource definitions

2.1 Introduction

2.1.1 Community resources and receptors are set out in the following section against the infrastructure themes of residential property, recreation infrastructure; community infrastructure; open and play space.

2.2 Community resources and receptors

Residential property

2.2.1 **Resources**: Residential property includes:

- private, rented and shared ownership residential dwellings and their surrounding grounds/gardens;
- student accommodation;
- extra care/retirement housing;
- mobile homes and residential boats where there is an established and recognised location for them to use (e.g. home, permanent or long term waterside moorings, caravan sites, traveller sites); and
- homes used in conjunction with a business or other function, for example, bed and breakfasts, farm houses and church rectories.

2.2.2 **Receptors**: Includes the owners or tenants of properties and mobile homes/boats in established locations. It also includes employees who permanently reside in a residential property, for example, care givers and janitors.

2.2.3 **Exclusions**: Residential health/social care facilities are covered under community infrastructure. Other community property will be considered under community infrastructure or recreation infrastructure. Travel accommodation such as hotels, bed and breakfasts and serviced apartment hotels will be included as businesses under the socio-economic assessment, except where the accommodation in question provides permanent residential dwelling for the owner/manager and/or staff then they are considered under community as well as socio-economic. Landlords or owners who do not reside in the property are also excluded.

Community infrastructure

2.2.4 **Resources**: Community infrastructure includes:

- health and social care facilities including GP practices and health centres, hospitals, hospices, residential care facilities, sure start centres, social work centres, health-related emergency services, and dentists;

- educational facilities including day nurseries, primary schools, secondary schools, colleges, universities, other organised learning environments and education resource centres;
- community centres, youth centres, and other relevant facilities used for local community meetings and activities;
- institutional uses defined as government local authority and emergency services which are open to the public;
- local high streets and local centres which provide local services including convenience retail and services such as post offices and hairdressers;
- places of worship (with some potential overlap with open space, e.g. burial grounds, cemeteries) and;
- local public transport infrastructure and services including for example bus services and bus stops.

2.2.5 **Receptors**: Users and beneficiaries of resources which include local residents, organised (community) groups, pupils, patients, congregations and employees who use community infrastructure. Receptors also include owners and organisations running the resources.

2.2.6 **Exclusions:** Employment impacts will be covered under the socio-economic assessment.

Open space and play space

2.2.7 **Resources**: Public open space including areas of land and water (such as rivers, canals, lakes and reservoirs) which offer opportunities for sport and recreation and could also act as a visual amenity[1].

2.2.8 Open spaces are limited to publicly accessible spaces. Open space that is privately owned and not available for use by the general public (e.g. woodlands on farmland) has been excluded from the assessment. However, land that is privately owned but open for public use (e.g. parks or gardens surrounding country houses) has been included in the assessment.

2.2.9 The following typology illustrates the broad range of open space resources that may be of public value, including play spaces:

- parks and gardens – includes urban parks, country parks and formal gardens;
- publicly accessible countryside in urban fringe areas;
- publicly accessible wider countryside;
- publicly accessible natural and semi-natural urban green spaces – includes woodlands, urban forestry, scrub, grasslands (e.g. downlands, commons and meadows), wetlands,

[1] Amenity can be defined as the pleasant or normally satisfactory aspects of a location which contribute to its overall character and the enjoyment of residents or visitors.

open and running water, wastelands and derelict open land and rock areas (e.g. cliffs, quarries and pits);

- access routes used for recreation – includes river and canal banks, recreational (off road) cycle routes, bridleway, and promoted recreational walking routes;
- short-stay canal and riverside moorings;
- outdoor sports facilities (with natural or artificial surfaces and either publicly or privately owned) – including tennis courts, bowling greens, sports pitches, golf courses, athletics tracks, school and other institutional playing fields;
- amenity green space (most commonly, but not exclusively in housing areas) – including informal recreation spaces, green spaces in and around housing, and village greens;
- allotments, community gardens, and city (urban) farms;
- cemeteries and churchyards;
- civic spaces, including civic and market squares, and other hard surfaced areas designed for pedestrians; and
- outdoor play spaces including provision for children and teenagers – including play areas, skateboard parks, outdoor basketball hoops, and other more informal areas.

2.2.10 **Receptors**: Users and beneficiaries of resources which include local residents, visitors, organised (community) groups, pupils, patients, congregations and employees who use community infrastructure. Receptors also include owners and organisations running the resources.

2.2.11 **Exclusions**: Employment impacts will be covered under the socio-economic assessment.

Recreation infrastructure

2.2.12 **Resources**: Recreation infrastructure related to public and commercial recreation facilities where not covered under open space and play space. Recreation infrastructure includes:

- sports centres and facilities, leisure centres and fitness clubs. (Some recreation facilities may include both indoor and outdoor recreation facilities, e.g. golf clubs, paintballing venues);
- stadia, arena and professional sports clubs which host games and events open to the public;
- indoor (publicly owned and commercial) children's play areas;
- museums, art galleries, theatres, cinemas, historic buildings and stately homes open to the public, other cultural venues and facilities;
- food venues, cafes, restaurants;
- music venues, bars, pubs, night clubs, social clubs (e.g. Irish clubs, Conservative clubs, Labour clubs, Working Men's clubs); and
- other recreation facilities, for example, theme parks, animal sanctuaries, zoos, aquariums, visitor centres, camp sites, equestrian facilities and showgrounds.

2.2.13 **Receptors**: Users and beneficiaries of resources which include local residents, visitors, organised (community) groups, pupils, patients and employees who use recreation infrastructure. Receptors also include owners and organisations that run the resources.

2.2.14 **Exclusions**: Outdoor and publicly accessible open spaces used for recreation which are already covered under open space, e.g. a public bridleway used for horse riding. Employment impacts will be covered under the socio-economic assessment.

2.3 Baseline of Community resources

2.3.1 Baseline data on Community resources (as defined above) will be compiled for the study area. The study area is taken as the area of land that encompasses the likely significant effects of the Proposed Scheme. An area 1km from the route of the Proposed Scheme, should be used as the starting point for collecting baseline data in rural areas, and 500m in urban areas. The study area may subsequently need to expand to include proposed construction traffic routes along which community resources could be affected by in-combination effects (see Section 3.2).

2.3.2 The future baseline should include committed developments that are assumed to have been implemented by the year of construction and operation and are relevant to the Community assessment. Committed developments may include site allocations in adopted local plans or extant planning permissions within the study area.

3 Community assessment criteria

3.1 Introduction

3.1.1 The Environmental Statement (ES) will use both the terms 'impact' and 'effect' in all environmental topics. An impact is generally considered to be a physical change caused by the Proposed Scheme (and in this context, changes in air quality, noise levels or the quality of a view for example will be 'impacts'). The consequences of impacts on the receptors will be generally termed 'effects'.

3.1.2 For the community assessments, resources will be the assets and facilities which are affected. Receptors are the operators, users or beneficiaries of those resources. Resources and receptors will vary for each type of impact and effect. So, for example, the impact of 'increased construction traffic' may have a range of impacts, such as congestion on the roads. The effects of this congestion could be disturbance and annoyance to local residents and disruption for users of community resources.

3.2 Impacts and effects

3.2.1 Impacts relevant to the community assessments fall broadly within the following categories:

- demolition and direct land possession;
- damage to property as a result of construction; and
- intrusion/disturbance to communities, and community facilities caused by presence of construction workers or other environmental impacts.

3.2.2 Impacts will generate the following broadly defined effects on receptors and resources:

- **loss or gain**: a loss or gain to a resource or receptor. For example, a decrease in housing stock as a result of demolitions, a reduction in playing pitches available within an open space or, a loss of all or part of a recreation resource, such as a golf course.
- **displacement**: the re-location of receptors from one location to another location within the study area, for example people moving from their homes to replacement homes (permanently or temporarily), or community venues moving from their existing premises;
- **in-combination effects**: the amenity value that resources offer receptors may be affected by a combination of factors including: noise and vibration; heavy goods vehicle (HGV) traffic; air quality; and visual impacts. Amenity value relates to the enjoyment of a resource by a receptor. The assessment of in-combination effects on community receptors will draw on the conclusions from other assessment topics taking into account

professional judgement about the sensitivity of the individual resource or receptors to the predicted effects[2];

- **isolation**: in the context of this assessment, isolation effects will be assessed by the barriers (including significant delays) local communities face in making their usual journeys. This includes physical, psychological and social barriers (i.e. non-economic) and the effects of this on local communities. Isolation of commercial and industrial buildings and land, and agricultural property and land, are addressed within the scope of the socio-economics and agriculture, forestry and soils assessments; and
- **capacity**: the ability of community facilities to accommodate any increased demand associated with the presence of construction workers.

3.2.3 Community effects will also need to be taken account of in the assessment of health and equality impacts. Integrated working between the community, equality and health assessments will ensure:

- establishment of a common baseline for the community areas that will meet the requirements for all disciplines;
- a co-ordinated approach to stakeholder engagement; and
- significant community effects are taken into account as part of the health and equality impact assessments.

3.2.4 The Equality Impact Assessment (EQIA) will be separately reported from the ES.

3.3 Assessment of significance

3.3.1 Significance should be determined by assessing both the magnitude of the impact and the sensitivity of resources and receptors for each effect. Taken together magnitude and sensitivity will determine whether effects were considered to be 'significant' or 'not significant'. All effects are to be assessed, including adverse and beneficial.

Magnitude of impact

3.3.2 In considering the magnitude of an impact on a resource and its receptors, assessors should consider each impact against the checklist of magnitude questions presented in List A. The questions are designed to assist in deciding on magnitude and judging whether there could be any specific circumstances in which the magnitude ranking should differ from the thresholds identified in Table 1. Not every question will be relevant to the circumstances of each individual impact.

[2] For the operational in-combination effects, the assessment is based on the first year of operation (2038) with the exception of noise which is based upon the service frequency associated with all of Phase Two (Phase 2a and the Proposed Scheme) operating.

3.3.3 Some situations/outcomes may not be known for certain. Assessors should base their work on an assessed most likely situation/outcome.

List A: Questions relevant to the assessment of magnitude of impact

3.3.4 **Scale of the impact/implications for receptors and functioning of the resource:**

- Is the impact of such a scale that it will affect the functioning of the resource?
- What is the scale of the impact on people's lives and activities?
  - Do other EIA topics conclude a significant effect?

3.3.5 **Duration of the impact:**

- What is the duration of the impact on a receptor?
  - Does the impact occur at specific times of the day?
  - For how long does the impact occur (short, medium or longer term)?
  - How regularly does the impact occur?
  - Is the impact temporary or permanent?

3.3.6 **Number of people affected/extent of use:**

- What is the spatial scope of the impact (i.e. to help inform judgement on the number of people affected)?
- How many people/what proportion of people, are likely to experience the impact?
- Generally the greater the number of people which experience an impact the greater the magnitude.
- But also consider people experiencing an impact as a proportion of the total people in a relevant community and/or group, i.e. if the number of people experiencing an impact is low but the proportion is high, then it may be appropriate to consider the magnitude as higher.

Sensitivity of receptors

3.3.7 In considering the sensitivity of receptors to an impact, assessors should consider each impact against the checklist of sensitivity questions given in List B. Not every question will be relevant to the circumstances of each receptor. The questions are designed to assist in deciding on sensitivity and judging whether there could be any specific circumstances in which the sensitivity ranking should differ from the thresholds provided in Table 1.

3.3.8 Some situations/outcomes may not be known for certain. Assessors should base their work on assessed most likely situations/outcomes.

3.3.9 For the assessment of in-combination effects, sensitivity should be considered as a separate step in the community assessment process. Where there is an overlap with other disciplines

and this is considered by assessors to be important they should ensure that the overall significance rating is consistent with the other relevant assessments.

List B: Questions relevant to the assessment of sensitivity

Availability of resources affected

3.3.10 What is the scarcity of the affected resource and what is the availability of alternatives? Factors to consider include:

- What is the catchment area of the affected resource?
- Are there comparable alternative resources available within the relevant catchment area?
- How easy is it to replace the resource? e.g. does it have special site requirements that are difficult to replicate or are its locational requirements generic and relatively easily met elsewhere?
- What is the spare capacity of the alternative resources and is this potentially available to the users of the affected resource?

Capacity of receptors to respond to change

- What is the capacity of the resource and the receptors that use it to experience a loss or gain of the affected resource?
- Nature of users – are they concentrated in the local area? Are they a specialised interest group? Are they local/regional/national/international? Does this nature then influence their capacity to experience a loss or gain in the affected resource?
- Are users concentrated in potentially more sensitive groups, such as people on low incomes, unemployed, or in areas of multiple deprivation? [3]
- How mobile are the receptors? e.g. are they likely to have access to a car? Do they have any physical constraints on their movement?

3.4 Assessment criteria and thresholds

3.4.1 Specific magnitude and sensitivity criteria and thresholds have been developed for each of the types of community impacts to be assessed. The assessment criteria described in Table 1[4] identify the types of impacts and effects on resources and relevant receptors. This includes guidance on the factors to consider and thresholds to ensure a consistent approach to assessing significance.

[3] Where receptors are within Protected Characteristics groups as in Equality Act 2010, effects will be assessed and reported within a separate EQIA Report.

[4] Table 1 builds upon the assessment guidance set out in the EIA Scope and Methodology Report, Section 9: Community.

3.4.2 Table 1 has been established using professional judgement and existing precedents and should be used as the starting point for assessment. In some instances it may be considered appropriate to adjust sensitivity and magnitude in the light of specific circumstances.

3.4.3 The approach is similar to that used for the community assessment reported in the ESs for HS2 Phase One and Phase 2a.

3.4.4 Table 1 will be used to determine both construction phase effects and operational effects. Whether a particular resource and receptor needs separate assessment for construction and operation will depend upon the specifics of the Proposed Scheme. Some receptors need different assessments for both construction and operation while other receptors will only require an assessment for one of the two. There will also be instances in which it will be appropriate to take into account the construction effects when carrying out the assessment of the operational impact, for example if a facility will be closed down during construction and would only be partly reopened during the operation of the railway.

3.5 Cumulative effects

3.5.1 The Community assessment reports three types of cumulative effects as defined in the SMR:

- community-wide effects;
- inter-project effects; and
- intra-project (in-combination) effects.

Community-wide effects

3.5.2 There may be instances where separate effects on individual community resources cumulatively have a wider impact on the broader community.

3.5.3 Community-wide effects will be reported as 'cumulative effects' in the ES. These are defined as occurring, as set out in the SMR, "where a number of individual impacts on resources come together within a location and have a wider impact on the community, such that they change the experience of a large proportion of people within that community".

3.5.4 Using the individual assessments conducted at community area (CA) level, community assessors should undertake a qualitative assessment of community-wide effects. This will require assessors to use professional judgement to consider whether the assessment findings on community resources and receptors in the CA have in aggregate identified matters that could be applicable/relevant at a community-wide level (i.e. having an appreciable effect across a large proportion of the community) as opposed to only affecting individually identified resources and associated receptors.

3.5.5 Assessment will either be undertaken at sub-CA or CA level. At sub-CA level this will involve carrying out assessments at the level of smaller geographical areas. These smaller areas would be typically aligned with obvious or clear spatial boundaries that separate or join-up geographic areas into distinct communities.

Inter-project effects

3.5.6 Some committed developments which are expected to be under construction at the same time as the Proposed Scheme could give rise to inter-project cumulative effects. For the Community topic, an assessment of inter-project cumulative effects should only be undertaken in instances where the Proposed Scheme and a committed development would both have a temporary or permanent direct construction impact on the same community resource. A potential scenario could be where HS2 and a cumulative project both require temporary use of a public open space for construction work at the same time. Where there is an interaction between the Proposed Scheme and Phase One or Phase 2a, the assessment should also consider whether this will give rise to significant inter-project in-combination cumulative effects.

Intra-project (in-combination) effects

3.5.7 These occur where two or more residual significant effects from other EIA topics (air quality, noise and vibration, HGV traffic or visual impact) coincide on a community resource and the associated receptors. In the ES Volume 2 Community reports, this type of cumulative effect is reported in the same sub-section as direct effects (resulting from land take or displacement) and isolation effects.

3.5.8 Community-wide and inter-project effects are reported separately in the ES Volume 2 Community report under the sub-section heading ‘Cumulative effects’.

Table 1: Guidance on assessing sensitivity and magnitude

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
1. Residential property	1.1 Residential property (including gardens) lost in part or whole to land required for construction or operation of the Proposed Scheme	Reduction in housing stock available for people	Displacement of home owners/ tenants, inconvenience and loss of their assets	Direct land required by HS2 Ltd either for the Proposed Scheme itself or for construction	• HIGH: • Permanent loss of 25 residential units or more • Temporary loss of garden space of 50 residential units or more – for more than three months • MEDIUM: • Permanent loss of 10 residential units or more • Temporary loss of garden space of 20 residential units or more for more than three months • LOW: • Permanent loss of five residential units or more • Temporary loss of garden space of 10 residential units or more for more than three months • NEGLIGIBLE: • Permanent loss of four residential units or less • Temporary loss of garden space of nine residential units or less for more than three months Possible variations: Where the number of dwellings affected is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact	
	1.2 In-combination effects of noise and vibration, HGV traffic, air quality and visual impacting on residents	Character or quality of residential properties change as a result, for example due to noise and vibration; HGV traffic;	Receptors' enjoyment of resource is changed	Relevant impact area from the edge of the route of the Proposed Scheme. Relevant impact area from the edge of the route of the Proposed Scheme is a minimum of 250m in both	At least five properties need to experience an effect for a resource to potentially experience a community impact. The primary test of magnitude will be the nature of the effects on the function of the resource. Also of relevance is the duration of the impact. Effect on function of resource and implications for receptors: • HIGH: • Three or more other residual significant effects	

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
		reduction in air quality; visual impacts		urban and rural areas unless subsequent analysis from other environmental topic areas suggests a greater or lesser extent at specific locations	• MEDIUM: • Two other residual significant environmental effects The in-combination assessment will only consider the in-combination significant residual effects from other topics so the LOW and NEGLIGIBLE categories are not considered to be applicable with regards to magnitude of impact. Potentially other topic effects[5] could include relevant elements of: Air quality; Landscape and visual; Sound, noise and vibration; and Traffic and transport (in terms of impacts of HGV (construction traffic) movements[6]). Duration: The duration of the impact should be taken into account. Generally speaking where duration is less than six months it may be appropriate to reduce the magnitude of the impact below the initial effect thresholds[7].	

[5] Some of the other topics will not assess all community resources potentially susceptible to in-combination impacts. For the community resources which fall into this category, the community assessor should liaise with the relevant topic assessors who can provide expert judgement on whether there is likely to be a residual significant effect.

[6] The HGV (construction traffic) movements' assessment assesses routes to be used by HGV construction traffic which will be significantly affected by the Proposed Scheme. Assessors should identify and map community resources whose sensitivity is considered susceptible to HGV construction traffic flows.

[7] Significant residual visual effects in operation are only reported for year 15 and year 30. Therefore, non-residual significant effects may last for a number of years following the opening of the railway. For this reason, these non-residual significant effects should be taken into account in the community operational in-combination assessment, with an acknowledgement that the effect will have been removed by year 15 of operation.

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
	1.3 Isolation of residential properties from other properties and infrastructure[8]	Physical e.g. islanding or isolation of resource	Social and community functioning/ integrity is damaged	Anticipated to cover some households up to 1km from the route of the Proposed Scheme and construction sites and depending upon specific context and proposals	At least five properties need to experience an effect for a resource to potentially experience a community impact. • HIGH: • Isolation (more than 12 months) of residences from their communities and services covering many of the other properties and/or much of the infrastructure that they typically connect with/access on an at least weekly basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • Isolation (6-12 months) of residences from their communities and services covering many of the other properties and/or much of the infrastructure that they typically connect with/access on an at least daily basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • MEDIUM: • Isolation (more than 12 months) of residences from their communities and services leaving them partially isolated from some of the other properties and/or infrastructure that they typically connect with/access on an at least a weekly basis.	

[8] This type of impact is different from the severance impacts assessed in the traffic and transport topic, which are focused solely on impacts on journeys.

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
					Occurs as a result of either road closure and/or moderate delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • Isolation (6-12 months) of residences from their communities and services leaving them mostly isolated from some of the other properties/infrastructure that they typically connect with/access on a weekly basis. Occurs as a result of road closure or moderate delay/disruption to journeys on a weekly basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • Isolation (1-6 months) of residences from their communities and services leaving them mostly isolated from some of the other properties and/or infrastructure that they typically access on a daily basis. Occurs as a result of road closure or moderate delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • LOW: • Isolation (more than 12 months) of residences from their communities and services from a small number of the other properties and/or amount of infrastructure that they typically connect with/access on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys.	

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
					• Isolation (1-12 months) of residences from their communities and services leaving them partially isolated from a small number of the other properties and/or amount of infrastructure that they typically connect with/access on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • Isolation (less than 1 month) of residences from their communities and services partially isolated from a small number of the other properties and/or infrastructure that they typically access on a weekly (or less frequent) basis. Occurs as a result of road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • NEGLIGIBLE: • No isolation (more than 12 months) of any residences from their communities and services from the other properties and/or infrastructure that they typically connect with or access on an infrequent basis. There may be short delay/disruption to routes to access services. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • Isolation (1-12 months) of any residential properties/communities from a small number of the other properties and/or infrastructure that they typically access on an infrequent basis. There may be short delay/disruption to routes to access	

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
					services. Can also occur as a visual barrier due to construction works surrounding residential dwellings. • Isolation (less than 1 month) of any residential properties/communities from a small number of the other properties and/or infrastructure that they typically access on an infrequent basis. There may be short delay/disruption to access services. Can also occur as a visual barrier due to construction works surrounding residential dwellings. Possible variations: Where the number of dwellings affected is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact. Assessors should review traffic and transport assessments of severance and journey delays to check for consistency with findings. These assessments are anticipated to be helpful for context and issues.	
2. Community infrastructure recreation infrastructure and open/play space	2.1 Infrastructure lost due to land required for construction or operation of the Proposed Scheme in part or in whole	Decline in facilities available for community use or temporary impairment of use	Loss of facilities and benefits for users, workers owners, and groups/ organisations. Any differential equality and health effects are reported in the Health sections of the	Direct land required by the Proposed Scheme	Below are details of characteristics (function and duration) typically associated with each magnitude of impact. Depending on the nature of the impact, the weight given by the assessor to each characteristic will vary so that it is not necessary that the assessed degree of impact takes account of both thresholds given under each magnitude. • HIGH: • Function/ability to absorb: Resource is completely closed/compromised and unusable for its intended purpose(s) • Duration: Long term (more than 12 months)	Below are details of characteristics typically associated with each sensitivity of impact • HIGH: • No comparable and accessible alternatives exist within the relevant catchment area • Highly or regularly used and valued resource

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
			ES or in the EQIA Report.		• MEDIUM: • Function/ability to absorb: Resource is partially closed/compromised and unusable for a proportion of its intended purposes • Duration: Medium term (6-12 months) • LOW: • Function/ability to absorb: Resource is compromised and its functionality is partly impaired or compromised • Duration: Short term (1-6 months) and reversible • NEGLIGIBLE: • Function/ability to absorb: Resource is not closed and can continue to be used for its intended purpose without any significant inconvenience or detriment to the users Duration: Short term (less than 1 month and fully reversible)	• MEDIUM: • Limited comparable and accessible alternatives exist within the relevant catchment area • Moderately or semi-regularly used and valued resource • LOW: • Many comparable and accessible alternatives exist within the relevant catchment area • Sparingly or infrequently used and valued resource Possible variations: It may be appropriate to vary sensitivity if receptors have limited ability to absorb change.
	2.2 In-combination effects of noise and vibration, HGV traffic, air quality and visual impacting on community	Character or quality of cities/towns/ neighbourhoods/ paths changes as a result of noise and vibration; HGV traffic;	Receptors' enjoyment of resource is changed. Any differential equality and health effects are reported in the Health	Relevant impact area from the edge of the route of the Proposed Scheme is a minimum of 250m in urban and rural areas unless subsequent analysis from	The primary test of magnitude will be the nature of the effects on the function of the resource. Also of relevance is the duration of the impact. Effect on function of resource and implications for receptors: • HIGH: Three or more other residual significant effects	Below are details of characteristics typically associated with each sensitivity of impact • HIGH: • There are limited/no comparable and accessible alternatives that exist within the

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
	infrastructure operations	reduction in air quality; visual impacts	sections of the ES or in the EQIA Report.	other topic areas suggests a greater or lesser extent at specific locations	• MEDIUM: Two other residual significant environmental effects The in-combination assessment will only consider the in-combination significant residual effects from other topics so the LOW and NEGLIGIBLE categories are not considered to be applicable with regards to magnitude of impact. Potentially other topic effects could include relevant elements of: air quality; landscape and visual; sound, noise and vibration; and traffic and transport (in terms of impacts of HGV (construction traffic) movements. **Duration**: The duration of the impact should be taken in to account. Generally speaking where duration is less than six months it may be appropriate to reduce the magnitude of the impact below the initial effect thresholds[9].	relevant catchment area • Resource/receptor has limited ability to absorb the change (e.g. this may be applicable for quiet gardens, quiet/solitary natural beauty spots, etc.) • Highly or regularly used and valued resource • MEDIUM: • There are limited comparable and accessible alternatives within the relevant catchment area • Resources/receptors have limited ability to absorb the change. • Moderately or semi-regularly used and valued resource • LOW: • Resource/receptor are able to relatively easily absorb the change (e.g.

[9] Significant residual visual effects in operation are only reported for year 15 and year 30. Therefore, non-residual significant effects may last for a number of years following the opening of the railway. For this reason, these non-residual significant effects should be taken into account in the community operational in-combination assessment, with an acknowledgement that the effect will have been removed by year 15 of operation.

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
						this may be applicable for sports fields and grounds or open spaces used for active recreation) • Where many comparable and accessible alternatives exist within the relevant catchment area. Sparingly or infrequently used and valued resource.
	2.3 Isolation of community infrastructure from other properties and infrastructure[10]	Physical e.g. islanding or isolation of resource	Social and psychological e.g. communities' integrity is damaged	Catchment area of affected resource where it is subject to severance	• HIGH: • Isolation (more than 12 months) of services from its community covering much of the relevant local community that it typically serves on at least a weekly basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • Isolation (6-12 months) of services from its community covering much of the relevant local community that it typically serves on at least a daily basis. Occurs as a result of either road closure and/or lengthy delay/disruption to journeys on at least a daily basis. Can also occur as	• HIGH: • No comparable and accessible alternatives exist within the relevant catchment area • Resources/receptors have limited ability to absorb the change • With a high proportion of more vulnerable user groups, e.g., children, elderly, disabled • MEDIUM:

[10] This type of impact is different to the severance impacts assessed in traffic and transport topic assessment, which are focused solely on impacts on journeys.

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
					a visual barrier due to construction works surrounding community infrastructure. • MEDIUM: • Isolation (more than 12 months) of services from its community leaving it partially isolated from some of the relevant local community that it typically serves on at least a weekly basis. Occurs as a result of either road closure and/or moderate delay/disruption to journeys on at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • Isolation (6-12 months) of services from its community leaving it mostly isolated from some of the relevant local community that it typically serves on at least a weekly basis. Occurs as a result of road closure or moderate delay/disruption to journeys on an at least a weekly basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • Isolation (1-6 months) of services from its community leaving it mostly isolated from some of the relevant local community that it typically serves on at least a daily basis. Occurs as a result of road closure or moderate delay/disruption to journeys on at least a daily basis. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • LOW: • Isolation (more than 12 months) of services from its community leaving it partially isolated from a small part of the relevant local community that it	• Limited comparable and accessible alternatives exist within the relevant catchment area • Resources/receptors have limited ability to absorb the change • With a mix of user groups • LOW: • Many comparable and accessible alternatives exist within the relevant catchment area • Resource/receptor are able to relatively easily absorb the change A narrow population of users with no specific vulnerable groups where access is a key issue; or a general mix of users.

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
					typically serves on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • Isolation (1-12 months) of services from its community leaving it partially isolated from some of the relevant local community that it typically serves on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • Isolation (less than 1 month) of services from its community leaving it partially isolated from some of the relevant local community that it typically serves on a weekly (or less frequent) basis. Occurs as a result of either road closure or minor delay/disruption to journeys. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • NEGLIGIBLE: • No isolation (more than 12 months) of services from its community that it typically serves on an infrequent basis. There may be short delay/ disruption to routes to access services. Can also occur as a visual barrier due to construction works surrounding community infrastructure. • Isolation (1-12months) of services from its community that it typically serves on an infrequent basis. There may be short delay/disruption to routes to access services. Can also occur as a visual	

Theme	Impacts	Effects: on resources	Effects: on receptors	Spatial scope	Magnitude of impact	Sensitivity of receptors/ resources
					barrier due to construction works surrounding community infrastructure. • Isolation (less than 1 month) of services from its community that it typically serves on an infrequent basis. There may be short delay/disruption to access services. Can also occur as a visual barrier due to construction works surrounding community infrastructure. Possible variations: Where the number of users is a high proportion of the size of a local community it may be appropriate to adjust the magnitude of impact Assessors should review traffic and transport assessments of severance and journey delays to check for consistency with findings. These assessments will be helpful for context and issues.	
3. Presence of Construction Workers	Presence of construction workers with consequent requirements	Increased demand from construction workers	Reduced availability for users, workers, owners, and groups/organisations	Catchment area of affected resources	The number of construction workers along the route and an assessment of: - Estimates of proportion of workers that will be local and commute to work - Estimate of proportion of workers that are expected to reside at worker accommodation sites - Estimate of workers that will chose to find temporary accommodation (e.g. lodgings or bed and breakfast) - Working hours of construction workers and whether workers are likely to reside in construction camps at weekends. - Estimated demand for use of community facilities (e.g. education and health).	Services and accommodation available in the local area that could be used by construction workers and their ability to absorb change in demand/requirements.

4 Community assumptions

4.1 Introduction

4.1.1 The key assumptions underlying the community assessment are set out in this section.

4.2 Community assumptions

4.2.1 The assessment will draw on other assessment topics where necessary to identify the primary sources of community impacts. Although the level and intensity of proposed construction will vary during the construction period, the assessment focusses on the construction activities and durations which could lead to the greatest potential impact.

4.2.2 The spatial scope of the assessment will vary, depending on the nature of the receptors and the impacts being considered. Whilst effects associated with construction or the land used for construction/operation will be confined to the immediate vicinity of the route of the Proposed Scheme, effects resulting from a combination of impacts or relating to the overall functionality of a community will typically apply to wider areas such as neighbourhoods or parishes.

4.2.3 The community assessment will consider the function of land rather than its ownership as the key parameter for assessing impacts associated with the Proposed Scheme.

4.2.4 The hybrid Bill will identify various categories of land required to facilitate the construction and operation of the Proposed Scheme. Some of these categories of land will have no impact on the ability of existing and future baseline uses of that land to continue both during construction and operation. For example, one category to which this applies is land above the line of tunnels.

4.2.5 Where practicable, land required solely during the construction period will be returned to its previous use after construction unless that use cannot continue or resume within a reduced area. Where the use cannot resume, the effect is treated as permanent.

4.2.6 The assessment will consider the construction phase, including a period of commissioning (2025-2038) and the first year of operation (2038), except where the assessment draws upon findings from other topic assessments which are reported for different years of operation.

4.2.7 The in-combination assessment will draw on the residual significant effect findings from Air quality, Landscape and visual, Sound, noise and vibration and Traffic and transport topics[11] (i.e. after mitigation has been taken into account by those topics) and combines these findings to determine whether there is a significant in-combination effect on the community. Findings from these topic assessments are not directly comparable in terms of the specific

[11] Findings from Traffic and transport topic are taken into account in the assessment of construction in-combination effects only.

scale of effect. Durations of contributing effects are only reported where they are reported by the source topic.

4.2.8 For the assessment of operational in-combination effects the noise assessment will be based upon the service frequency associated with all Phase Two (Phase 2a and the Proposed Scheme) operating.

4.2.9 Significant residual noise and air quality effects are assumed to continue throughout the duration of the operation of the railway. Significant visual effects are reported at years 1, 15 and 30 of operation. Where visual effects are reported as significant at year 1 of operation but not at year 15, these will be taken into account in the operational in-combination assessment (as their duration beyond year 1 cannot be determined), with an acknowledgement that the residual effect will have been removed by year 15 of operation.

4.2.10 Community resources will be mentioned expressly in the environmental baseline only where they contribute to the local context or where they may be affected by the Proposed Scheme. Consequently not all community resources within the study area will be mentioned.

4.2.11 Effects relating to the severance of public rights of way (PRoW) (public footpaths and bridleways) and highway and pedestrian diversions, are assessed under the Traffic and transport topic. However, where PRoW and other routes are a "promoted" destination in their own right as a recreation resource, they will be considered within the community assessment. Where impacts on open space and PRoW are considered, these have been informed by open space and PRoW condition surveys, where it has been possible to undertake such surveys.

4.2.12 Open space surveys will be undertaken by community assessors in order to collect primary survey data on use of such spaces. Assessors will survey each site on one week day. Surveying will aim to avoid adverse weather conditions and weather conditions will be recorded for each survey. Any variations from this and the reasons for this will be reported in the individual open space survey records to be published alongside the ES.

4.2.13 Where open space is privately owned and not available for use by the general public (e.g. woodlands on farmland), it will be excluded from the assessment. However, where land is privately owned but open for public use (e.g. parks or gardens surrounding country houses) it will be included in the assessment.

4.2.14 The community assessment contained in the ES Volume 2 CA reports will report on all significant community effects as well as those effects which are not significant but are considered of importance to reference given their relevance to the study area which represents each CA.

4.2.15 The different assessments within the community section (residential property and community infrastructure affected by land required for construction and operation of the Proposed Scheme, isolation and in-combination effects) are not directly comparable when considering significance of effect. Assessments will be considered in aggregate as part of the community-wide analysis which will be presented in the under Cumulative impacts in the Community section of the Volume 2 CA reports.

4.2.16 Isolation effects will be included within the scope of this assessment and the analysis will consider physical separation, major increases in delay/disruption (as identified in the Transport Assessment), and the psychological barrier effects (including those which may be caused by visual barriers, such as residential properties located amongst construction works) that might impair links between residents and their facilities. Isolation is assumed to be a phenomenon that will occur as a result of the construction of the Proposed Scheme and can be either a temporary or permanent effect.

4.2.17 Increases in HGV construction traffic flows as a result of construction of the Proposed Scheme will affect the amenity of local communities. Community assessors should obtain this information from the Transport Assessment. This aspect of the assessment is concerned with the presence of HGV on highways and their proximity to community resources.

4.2.18 Information on duration of significant residual effects will be provided by other environmental topics where available. Where the relevant information is available, community assessors will use this identify when significant residual effects from other topics occurred simultaneously.

4.2.19 Professional judgement will be provided by other topics (i.e. Sound, noise and vibration, Landscape and visual and Air quality) to inform the in-combination assessment. Any significant effects findings established through professional judgement will be used in the same way as assessment findings derived through quantitative assessment.

4.2.20 The sound, noise and vibration topic assumes all PRoW (with the exception of those that exist in tranquil areas) to be, by their nature, transitory routes with users not staying in any one location for a long period of time and hence these PRoW will not be included within the sound, noise and vibration assessment scope. Consequently, noise effects on PRoW will not be considered to be significant (unless the assessment identifies significant SNV on areas prized for their tranquillity and hence the PRoW therein) as a result of construction and operation of the Proposed Scheme.

4.2.21 The assessment methodology will exclude, for the purposes of reporting in-combination effects, residential properties where the total number of dwellings is fewer than five. There will be a number of individual properties scattered along the route where impacts may be experienced from other topics. These impacts will be assessed, where relevant, in other topic chapters.

4.2.22 Residential properties which will be impacted by the Proposed Scheme will be grouped together either by street, hamlet or village. In some circumstances along the route other topics, such as sound, noise and vibration, will group residential properties slightly differently. In these situations, community assessors will liaise with the relevant topic to determine professional judgement with regards to the residential grouping.

4.2.23 Community resources identified as part of inter-project (cumulative) schemes may interact with the Proposed Scheme during their construction and as a result of their occupation by new receptors during the time when the Proposed Scheme is being constructed and beyond.

Annex E – Technical notes: Ecology and biodiversity

The following technical notes are contained in this annex:

- Ecology and biodiversity – Ecological impact assessment;
- Ecology and biodiversity – Ecological field survey methods and standards; and
- Ecology and biodiversity – Ecological principles of mitigation.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Ecology and biodiversity – Ecological impact assessment

Contents

1 Introduction

1.1 Purpose of the technical note

1.1.1 This technical note sets out the methodology used to assess the ecological effects (Ecological Impact Assessment (EcIA)) of the Proposed Scheme in the Environmental Statement (ES).

1.1.2 This technical note expands on the information included in the Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR).

1.2 Purpose of Ecological Impact Assessment

1.2.1 As part of the EIA process, the purpose of the EcIA methodology is 'to provide decision-makers with clear and concise information about the likely significant ecological effects associated with a project'.

1.2.2 It is also important that all other interested parties, including members of the public, are able to understand:

- the findings of the assessment;
- the process by which the assessment was undertaken; and
- the actions required to deliver the mitigation and compensation designed to ensure an appropriate biodiversity outcome.

1.2.3 This methodology has been designed with the aim of providing a clear and transparent assessment of the ecological effects of the Proposed Scheme to all readers.

1.3 Other relevant guidance

1.3.1 The impact assessment methodology incorporates the key principles of the standard method for ecology as set out by the Chartered Institute of Ecology and Environmental Management (CIEEM).

1.4 Structure of the report

1.4.1 This technical note provides information on evaluating ecological features in Section 2; on predicting impacts of the Proposed Scheme in Section 3 and on defining and assessing the significance of the resulting ecological effects in Section 4.

1.4.2 Section 5 of the technical note introduces the approach to recording mitigation, compensation and enhancement within the assessment and Section 6 provides information on the consideration of residual effects.

1.4.3 This technical note does not address the earlier stages of EcIA, notably definition of the scope of the assessment, as this is covered in the SMR.

2 Determining value of ecological resources

2.1 Introduction

2.1.1 This section provides guidance on how to assign value to ecological features. As acknowledged in the CIEEM guidelines, defining the value of ecological features does not follow a simple mechanistic approach but rather derives from professional judgement based on available guidance and information, along with supporting expert opinion. Nonetheless, it is recognised that on this project (given its scale and the number of survey teams involved), guidance is required in order to ensure a consistency of approach.

2.1.2 Ecologists undertaking the assessment should use their knowledge of the local context of the sites, species and habitats they are evaluating in determining the value of ecological features. Internal discussion between ecological teams about the evaluation of ecological features will be encouraged to maximise consistency in evaluation. The views of relevant stakeholders should also be considered as appropriate.

2.1.3 In determining the value of ecological features, the CIEEM approach should be adopted, whereby the ecosystem services value of ecological features is considered separately from the 'ecological' value, and the significance of any social and economic effects is (where applicable) are defined and reported within the Community and Socio-economics sections of the ES.

2.2 Evaluation: scale and reporting

2.2.1 A common difficulty in undertaking EcIA for large-scale or linear projects is the need to define a scale at which the baseline evaluation is undertaken or reported, i.e. what constitutes an individual ecological feature. This is particularly the case where there is a wealth of baseline data which relate to different or overlapping sampling areas.

2.2.2 For a small development site, it is easy to define and present the ecological features considered within the EcIA. Essentially, the development site is evaluated according to:

- any designations;
- other habitats within the site; and
- other species within the site.

2.2.3 Effects are then identified for each of the features (habitats and species) present. However, the geographic boundaries of the site which forms the basis of the assessment do not have any ecological validity – they are defined by the development proposal.

2.2.4 The conclusions of the EcIA for the Proposed Scheme will be reported in the ES within separate reports (Volume 2 of the ES), which sub-divide the route and report effects based on each community area (CA). The cumulative effects on ecological features at the route-wide level (i.e. those effects above and beyond those reported within the CA reports) will be

considered in Volume 3 of the ES. Effects on ecological features as a result of off-route works will be considered in Volume 4 of the ES.

2.2.5 Within each CA, there will be many individual features of ecological significance identified. These will include:

- designated sites;
- areas of semi-natural habitat; and
- areas of habitat or other features supporting notable species.

2.2.6 The designated sites will be evaluated based on the level of nature conservation value assigned through designation. Impacts and any resulting effects on designated sites will be assessed taking into consideration the combination of habitats and/or species which are identified as reasons for designation.

2.2.7 Whilst the CA boundaries will be used to sub-divide the ES, the evaluation process, including decisions on an appropriate scale to provide evaluation of ecological features, will not be defined by their extent.

2.2.8 For the habitats, species and other features of interest professional judgement will be used to identify the most ecologically meaningful scale to evaluate the ecological features present.

2.2.9 In the vast majority of situations evaluation of ecological features should be conducted according to one of the two approaches listed below:

- the areas of habitat and other features could be evaluated individually (i.e. a discrete block of a particular habitat type, or the population of great crested newt supported by a single pond); or
- grouping blocks of similar habitat, or areas supporting protected species on the basis of sound ecological reasoning (e.g. evaluating blocks of habitat of similar nature that occur in close proximity either side of a CA boundary as a single receptor; or evaluating the great crested newt population of a series of ponds together when it is clear that these are likely to function as a metapopulation).

2.2.10 Evaluation at the CA level may be appropriate for some widespread ecological features. However, this should be the exception and should not be the default approach.

2.3 General principles of evaluation

2.3.1 Evaluation of all potential ecological receptors should be conducted against the following frames of geographic reference:

- international or European;
- national;
- regional;
- county/metropolitan;

- district/borough;
- local/parish; and
- negligible.

2.3.2 The above represent a minor variation to those identified within the CIEEM guidelines. The frames of reference 'within zones of influence' and 'site' have been omitted for the purposes of this assessment due to potential confusion associated with the use of these terms in relation to a linear scheme on a large scale.

2.3.3 In line with the principles laid out within the CIEEM guidelines it is not considered possible to rigidly assign habitats or species to a specific level of value, as the value of the ecological feature may vary depending on where on the route of the Proposed Scheme it occurs. Evaluation should be based on available information and guidance, including published criteria where available and professional judgement. The views of relevant stakeholders should also be considered as appropriate. Appendix A seeks to provide an outline framework for the evaluation of receptors.

2.3.4 In line with the CIEEM guidelines for valuing ecological features, a clear rationale for the valuation reached should be presented in all cases.

2.4 Designated sites

2.4.1 For formally designated sites the valuation afforded should be based on the value prescribed by the designating body. Where a feature has value at more than one level, its overriding value is that of the highest level. Where sites overlap and the features for which the site has been designated at each level differ these should be valued and assessed accordingly.

2.4.2 Potential Sites of Special Scientific Interest (pSSSI), candidate Special Areas for Conservation (cSAC)[1], proposed Special Areas of Conservation (pSAC)[2], potential Special Protection Areas (pSPAs) and proposed Ramsar sites should be considered to be of the same value as corresponding sites that have already been designated.

2.4.3 Habitats and species occurring within sites which have not been formally designated (e.g. potential local wildlife sites) should as a general rule be evaluated as part of the habitats and species assessments. Where surveys by the designating body have identified that a site meets the criteria for formal designation and it is in the process of being formally designated, then such sites can be assumed to be of the value prescribed by the designating body.

[1] Sites are submitted to the European Commission as candidate Special Areas of Conservation (cSACs). Only following approval by the European Commission are they designated by the Member State as Special Areas of Conservation.

[2] Prior to its submission to the European Commission as a cSAC, a proposed SAC (pSAC) is subject to wide consultation.

2.4.4 All habitats and species occurring within the boundaries of the designated site (including both features for which the site is designated and those that are not a reason for designation) should also be considered under the evaluation of habitats and species (as described below) to ensure that the subsequent assessment provides a true indication of potential effect on conservation status of these habitats/species.

2.4.5 It is not the role of the EcIA process to validate site designations but if a designated site is considered no longer to meet the criteria for designation, then the issue should be discussed with the relevant designating authority. Unless agreement is reached that the site does not match its current designation, then the current designated value should be used in the assessment.

2.5 Habitats

2.5.1 Habitats should be evaluated using published criteria for the recognition of sites supporting habitats of value at particular geographic scales. This will include criteria developed to identify habitats of international[3] or national[4] value. Similarly, some County Wildlife Trusts and/or Local Authorities have prepared criteria for the selection of local sites on the basis of their habitats.

2.5.2 Published criteria often make reference to UK priority habitats. The UK Biodiversity Action Plan[5] defines habitats and species that are conservation priorities because of their rarity and rate of decline. A review of the list of priority habitats in 2007 led to the identification of 65 habitats that meet the criteria at UK level. While the UK BAP has now been superseded, the priority habitat definitions remain relevant as they also underpin the Habitats of Principal Importance under Section 41, (S41) of the Natural Environment and Rural Communities Act (2006)[6], which mirror the categories originally defined for the UK BAP. Fifty-six habitats of principal Importance are included on the S41 list. These are all the habitats in England that have been identified as requiring action in the UK Biodiversity Action Plan (UK BAP). They range from habitats such as upland hay meadows to lowland mixed deciduous woodland and from freshwater habitats such as ponds to marine habitats such as subtidal sands and gravels.

2.5.3 The published selection criteria typically take account of the following:

- rare or uncommon habitats;
- typical or characteristic habitats;

[3] McLeod, CR, Yeo, M, Brown, AE, Burn, AJ, Hopkins, JJ, & Way, SF (eds.) (2005), *The Habitats Directive: selection of Special Areas of Conservation in the UK*. 2nd edn. Joint Nature Conservation Committee, Peterborough. Available online at: www.jncc.gov.uk/SACselection

[4] Joint Nature Conservation Committee (2019), *Guidelines for selection of biological SSSIs.* Available online at: http://jncc.defra.gov.uk/page-2303.

[5] Joint Nature Conservation Committee (1994), *UK Biodiversity Action Plan*.

[6] *Natural Environment and Rural Communities Act (2006),* (Chapter 26). Her Majesty's Stationery Office.

- species-rich habitats;
- habitats that develop slowly and are thus difficult to replace; and
- local context.

2.5.4 Where criteria for recognising habitat receptors of value at a county or district level do not exist, experience and professional judgement should be used for their evaluation. Justification for the value assigned to any habitat or site should be clearly and concisely set out, focusing on the factors listed above.

2.5.5 The evaluation of habitats should be made independent of any related value that the habitat has as a consequence of the protected species which it supports.

2.5.6 Assessment should include consideration not only of similar habitats but also the potential for a greater overall value of a wider habitat mosaic, as a consequence of what might be regarded as a synergistic assessment. Thus, an area that is of district value for several different habitats might be considered, overall, to be of county value as a consequence of the combination of habitats. Such judgements should be documented clearly.

2.5.7 Habitats within designated sites should also be considered within the evaluation of the wider habitat resource. Cross referencing to the designated sites section should be used as appropriate to prevent the need to repeat baseline descriptions.

2.6 Species

2.6.1 As with habitats, there will usually be published criteria for assessment of sites supporting species and assemblages of species that are considered as qualifying features for designated sites of nature conservation value at different geographic scales (e.g. The Birds Directive: selection guidelines for Special Protection Areas (JNCC, 1999)[7].

2.6.2 Published criteria often make reference to UK priority species. The UK Biodiversity Action Plan (1994)[8] defines habitats and species that are conservation priorities because of their rarity and rate of decline. A review of the list of priority species in 2007[9] led to the identification of 1,150 species that meet the criteria at UK level. Species were assessed according to four criteria:

- threatened internationally;
- international responsibility and a 25% decline in the UK;
- more than 50% decline in the UK; or

[7] Joint Nature Conservation Committee (1999), *The Birds Directive: Selection Guidelines for Special Protection Areas.*

[8] Joint Nature Conservation Committee (1994), *UK Biodiversity Action Plan.*

[9] Report on the species and habitat review. Report by the Biodiversity Reporting and Information Group (BRIG) to the UK Standing Committee June 2007.

- other important factors, where quantitative data on decline were lacking but there is other evidence of extreme threat.

2.6.3 While the UK BAP has now been superseded, the priority species definitions remain relevant as they also underpin the Species of Principal Importance under S41 of the Natural Environment and Rural Communities Act (2006), which mirror the categories originally defined for the UK BAP. There are 943 species of Principal Importance included on the S41 list. These are the species found in England which have been identified as requiring action under the UK BAP. In addition, the Hen Harrier has also been included on the S41 list because without continued conservation action it is unlikely that the Hen Harrier population will increase from its current very low levels in England.

2.6.4 Other criteria typically take account of the following:

- rare or uncommon species;
- species suffering a marked decline;
- endemic species;
- typical or characteristic species;
- species for which the area holds a significant proportion (e.g. European species for which England holds a significant proportion); and
- large or notable populations of species.

2.6.5 Protected and/or notable species should be evaluated wherever possible at the population level. Assessment teams should liaise to ensure that similar assumptions are made in relation to the scale of evaluation for highly mobile species such as bats and birds.

2.6.6 Protected species populations occurring within designated sites should also be evaluated within this section at an appropriate scale (i.e. the boundaries of the designated site should not be a constraint to the way in which the ecological feature is evaluated).

2.6.7 Species populations found at the edge of or beyond their natural range may be worthy of valuing highly or not. A case-by-case judgement is likely to be appropriate in this situation and should be briefly explained in the baseline evaluation.

2.6.8 All criteria listed previously should be employed in the context of professional understanding. Some species that have suffered decline in numbers may still be common or be expected to recover and so may not be valued as highly as other species in this category.

2.6.9 The CIEEM Guidance distinguishes between the evaluation of species of biodiversity value and those that are legally protected. In many cases, species fall in to both categories, thus, for example, great crested newt (*Triturus cristatus*) is protected under the Habitats Directive and the Wildlife and Countryside Act 1981 (as amended) because it is considered to be of biodiversity value. The distinction between biodiversity value and legal protection allows one to draw the necessary distinction between the importance of a single pond with great crested newt and a series of ponds with a metapopulation that would qualify for designation as a SSSI.

2.7 Baseline trends

2.7.1 The impact assessment considers the baseline conditions that would exist with and without the Proposed Scheme. It is therefore important to predict baseline conditions for the construction period (for construction impacts) and for the date of opening and beyond (for operational impacts). Key dates are provided in Table 1.

Table 1: Assessment years

Phase	Year(s)
Construction	2025 to 2038
Operation Year 1	2038

2.7.2 Due to the complexity of the Proposed Scheme and the potential for changes in construction phasing when detailed design is progressed, the ecological assessment will be based on the assumption that construction activity across the route will commence in 2025.

2.7.3 In predicting future baseline conditions at the start of construction and operation, consideration should be given to environmental trends (range expansion, population declines etc.) as well as influences such as policy that will influence land use and consented or highly likely development proposals.

2.7.4 Based on current best evidence, it is considered unlikely that ecological features will be significantly different by either 2025 (construction baseline) or 2038 (operational baseline). The EcIA therefore concentrates on reporting the likely effects of climate change at the route-wide level within Volume 3 of the ES.

2.8 Precautionary valuation

2.8.1 Due to access restrictions, access delays and seasonal restrictions on survey, there will be areas of the route where the desired survey scope will not be complete at the point of the ES submission.

2.8.2 In order to ensure that all likely significant effects of the Proposed Scheme have been identified, where baseline information is incomplete a precautionary approach of assuming a 'reasonable worst-case' valuation should be adopted. This approach should be utilised to assign precautionary valuations to both known ecological features, and potential ecological features based on the best available information.

2.8.3 Where reasonable worst-case valuations are necessary they should be made based on the information available. This should include consideration of any available field or desk study data (including aerial photography), a comparison with similar habitat areas occurring in the wider local area, and a qualitative consideration against any factors that indicate suitability for the particular habitat or species in question. The degree of precaution built into the assessment should be linked to the level of confidence in the existing data upon which the assessment is based. Further guidance is provided in Appendix B of this technical note.

3 Impacts

3.1 Construction impacts

3.1.1 Site preparation and construction activities will include:

- demolition of buildings;
- clearance of vegetation;
- site levelling;
- earthworks including: excavation, topsoil/subsoil stripping;
- laying of substrates and construction materials;
- introduction of railway infrastructure, including catenary system;
- storage of machinery and materials;
- security and site lighting;
- installation of site fencing (temporary and permanent);
- construction and installation of noise fence barriers;
- planting of landscaping areas;
- construction of roadways, underpasses and bridges where re-alignment of existing roads are required;
- construction of paths, underpasses and bridges where re-alignment of public rights of way (footpaths and bridleways) are required;
- culverting of watercourses under the railway line;
- construction of ditches, drains and watercourses where new or realigned drainage is required; and
- transport of materials and workers to and from site.

3.1.2 The construction area will include land required for mitigation, notably noise barriers and landscaping areas. It will also include land required for road and utility re- alignment.

3.1.3 Impacts arising from the permanent presence of the railway line, associated structures (including catenary), and landscaping etc. are considered to be permanent construction effects and will be reported in the construction section.

3.1.4 Potential impacts resulting from site preparation, construction activities and the permanent presence of the route are likely to include:

- loss of habitat to land required for the construction and operation of the Proposed Scheme;
- severance of ecological corridors and networks, resulting in a reduction in habitat connectivity;
- fragmentation of habitats and sites;
- barrier effects (to movement of fauna);

- direct mortality from collision with overhead structures, including catenary system;
- noise and visual disturbance;
- vibration disturbance;
- disturbance from lighting;
- dust deposition;
- air pollution;
- water quality changes from surface water run-off carrying sediments and pollutants;
- hydrological effects, from changes in water levels and/or flows;
- changes in management, often resulting in habitat degradation;
- changes in public access;
- introduction of 'alien' geology where use of imported substrates results in mixed geologies; and
- introduction and spread of invasive non-native species.

3.1.5 It should be noted that changes in public access may affect sites some distance from the Proposed Scheme. If, for example, an area of much-used public open-space is lost to the community, either temporarily or permanently, other sites may see a consequent increase in use. Thus, the usual potential effects of increased recreational use (disturbance to sensitive species, eutrophication, erosion, increased risk of fire etc.) may occur well away from the Proposed Scheme where alternative sites are in short supply.

3.1.6 It will be assumed for the purposes of the EcIA that all existing habitats within the extent of the Proposed Scheme (i.e. both areas of land required for the construction and operation of the Proposed Scheme) would be permanently lost. This represents a precautionary assessment and it is likely that during detailed design it will be possible to identify some features that can be retained.

3.2 Operational impacts

3.2.1 Operational activities will include:

- passage of trains; and
- maintenance activities.

3.2.2 Operational impacts derive only from these activities and do not include the permanent presence of the railway line, associated structures (including catenary, landscaping etc.).

3.2.3 Potential impacts resulting from operational activities are likely to include:

- barrier effects (to movement of fauna);
- direct mortality or injury from collision with trains;
- mortality or injury from potential turbulence effects;
- noise and visual disturbance;

- vibration disturbance;
- water quality changes from surface water runoff carrying sediments and pollutants (both from routine activity and accidental spillages); and
- introduction and spread of invasive non-native species.

3.3 Characterising impacts

3.3.1 Having identified the impacts that are likely to arise from construction and/or operational activities at any one location, it is necessary to consider the characteristics of impacts in terms of:

- positive or negative;
- magnitude;
- spatial extent;
- duration;
- timing (both in terms of time of day and time of year); and
- frequency and periodicity.

3.3.2 These characteristics are important in determining likely ecological effects.

3.3.3 Magnitude refers to the 'size' or 'amount' of the impact and should be reported on a quantitative basis wherever possible. The extent of an impact is the area over which the impact occurs and this again should be reported on a quantitative basis.

3.3.4 The duration of impact should be considered in relation to ecological characteristics (for example species lifecycles) as opposed to human timeframes (CIEEM guidelines). It should be noted that the duration of the impact and the resulting effect on receptor may differ. For example, if disturbance during construction results in several years of reduced juvenile recruitment for a species then the effect on the conservation status of the species concerned may continue to be significant for generations.

3.3.5 When describing the reversibility of impacts, the terms 'permanent' (i.e. irreversible) and 'temporary' (i.e. reversible) should be used when characterising an impact.

3.3.6 Within the characterisation of impacts an indication should be provided of the likelihood that a change/activity will occur as predicted.

3.3.7 In line with the overall EIA of the Proposed Scheme, the EcIA will make a clear distinction between the terms 'impact' and 'effect', using the definitions below:

- impact = activity associated with the Proposed Scheme resulting in changes acting on an ecological feature; and
- effect = outcome resulting from an impact acting upon a receptor.

4 Assessment of effects

4.1 Definition of significance

4.1.1 Having defined and assessed both the baseline ecological features and the predicted impacts, it is necessary to consider how the predicted impacts could affect the valued ecological features and thus to identify likely significant ecological effects.

4.1.2 Following the CIEEM guidance, a significant ecological effect is defined as an effect that either supports or undermines biodiversity conservation objectives for 'important ecological features' or for biodiversity in general. Conservation objectives may be specific (e.g. for a designated site) or broad (e.g. national/local nature conservation policy) or more wide-ranging (enhancement of biodiversity). Effects can be considered significant at a wide range of scales from international to local.

4.1.3 Effects on designated sites will be considered in relation to the site's conservation objectives, and the conservation status of species or habitats for which the site is designated, or effects on the condition of the site or its interest/qualifying feature. Effects on species and habitats will be considered in relation to the concept of 'conservation status'. Effects on ecosystems will be considered in relation to changes to ecosystem structure and function.

4.2 Assessment of whether ecological effects are significant

4.2.1 In line with the approach laid out in the CIEEM guidelines, the value of ecological features will be used to identify the geographic scale at which the effect is significant.

4.2.2 Effects of the Proposed Scheme will be assessed following the incorporation of avoidance/mitigation measures that are included within the design. This will include all relevant measures even if their primary purpose was not to reduce or avoid ecological impacts. For example, this may include the following:

- changes to the route (i.e. horizontal alignment) of the Proposed Scheme;
- changes to the vertical alignment (e.g. depth of cuttings);
- use of tunnels;
- design of standard bridges, overpasses etc. (excludes green bridges[10] or the greening of structures already proposed);
- use of specific construction methodology to minimise the land required (e.g. retaining walls);

[10] Green bridge is a structure with vegetation, providing habitat connectivity across the route of the Proposed Scheme.

- underpasses/conduits where the primary purpose is not for ecological benefit;
- fencing where the primary purpose is not ecological; and
- implementation of the draft Code of Construction Practice (CoCP).

4.2.3 Effects should be reported prior to any additional mitigation, compensation or enhancement proposed, which will be introduced later in the assessment process.

4.2.4 Key to predicting significant ecological effects is understanding what might affect the integrity of a defined site and/or the conservation status of the habitats or species supported by the defined site or area.

4.2.5 CIEEM guidance recommends that the process of identifying significant ecological effects should make explicit reference to aspects of ecological structure and function on which the feature depends.

4.2.6 The integrity of a site is defined as 'the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified'[11]. For all designated sites the assessment of the effect on site integrity should only consider the features for which the site is designated.

4.2.7 Once impacts that could affect a site have been identified, they can be evaluated against the environmental factors necessary to maintain the integrity of the site, with consideration being given to the timing, duration, reversibility, extent and magnitude of any effect. Professional judgement will be used, as appropriate, to make the final judgement as to whether there will be a significant effect.

4.2.8 For designated sites of international and national value, assessment of the potential effects on integrity should make explicit reference to any published conservation objectives.

4.2.9 Similarly, for some species and habitats (notably those with Biodiversity Action Plans) there may be objectives for the conservation status of the species/habitat.

4.2.10 Where impacts are anticipated to result in an adverse effect on site integrity, then this should be considered significant at the same geographical scale at which the site is valued. However, when considering adverse effects on conservation status of habitat and species, where an effect is not found to be significant at the level at which the resource/receptor has been valued, it may in some cases be significant at a lower level.

4.2.11 A 'worst case' rule is to be applied to assessment of the future baseline, in order to take account of uncertainty: significance of effect outcomes arising through the future baseline will only be reported where effects worsen over those reported against the current baseline. As a result of this rule, mitigation and compensation will be provided in line with a 'worst case' assessment.

[11] ODPM Circular 06/2005; Biodiversity and geological conservation – Statutory obligations and their impact within the planning system.

4.3 Cut-offs for reporting purposes

4.3.1 Individual effects at the local/parish level are as a general rule not to be reported in Volume 2 CA reports as they are not considered to represent material considerations in the decision-making process for the Proposed Scheme. Exceptions may be made where it is considered necessary to demonstrate that particular issues have been considered, such as where an adverse effect occurs at a lower geographic scale than that at which the receptor was valued.

4.3.2 A register of local/parish level effects will be produced and will form an appendix (Volume 5) to the ES. Potential cumulative and in-combination effects of multiple local/parish level effects will be considered in the route-wide assessment (Volume 3 of the ES).

4.4 Cumulative effects

4.4.1 Cumulative effects include:

- the combined ecological effect on a single receptor of a number of individual environmental impacts (e.g. the loss of habitat to land required for construction and operation of the Proposed Scheme, combined with noise and airborne dust) arising from the Proposed Scheme;
- the cumulative effects of localised ecological impacts along the length of the Proposed Scheme; and
- interaction between ecological effects arising from the Proposed Scheme and those from other relevant projects and plans which take place during the construction or operational phases[12].

4.4.2 The cumulative effects resulting from the accumulation of effects summed in a regional context or over the whole route, resulting in an effect or effects of greater significance than the sum of the individual effects, will be reported in the route-wide report (Volume 3 of the ES).

4.4.3 The wider effects of climate change on the likely effects as a consequence of the Proposed Scheme, and the effects of the Proposed Scheme on the ability of habitats and species to respond to future pressures of climate change, will be reported primarily as part of the route-wide ecology assessment in Volume 3 of the ES.

4.4.4 The effects of climate change, when considered in combination with predicted effects arising from construction and operation of the Proposed Scheme, may exacerbate the ecological effects of the Proposed Scheme but are unlikely to result in any effects of greater

[12] A future development is considered to be part of the future baseline for the Proposed Scheme if it changes the local environment in the area relevant to the assessment (or creates additional receptors) prior to 2025 or 2038 (for construction and operational future baselines, respectively). A future development is considered to contribute cumulative effects if its construction or operation occur contemporaneously with the Proposed Scheme and increase the effects of HS2 on receptors.

significance. Nonetheless, consideration will be given to the situations in which ecological effects arising from future climate change may exacerbate the effects of the Proposed Scheme and any consequent changes in levels of significance will be reported within the CA reports. In particular, if the in-combination analysis suggests that existing mitigation measures need to be enhanced or additional mitigation is required, this will be clearly identified. For the purposes of this analysis, '2020' climate predictions will be used for construction effects and '2050' for operational effects. In addition, any regional or local policies and guidance on climate change impacts, risks and adaptation will be considered.

5 Mitigation, compensation and enhancement

5.1 Approach to mitigation, compensation and enhancement

5.1.1 Following the assessment of effects, the ecology sections of the Volume 2 CA reports will present details of the further mitigation, compensation and enhancement measures (i.e. those in addition to the fundamental engineering design) that are proposed to address the anticipated effects. In describing such measures terminology should explicitly distinguish between mitigation, compensation and enhancement as defined within the CIEEM guidelines.

5.1.2 For each significant adverse ecological effect, appropriate mitigation or compensation will be identified where feasible. This mitigation or compensation proposed will be informed by professional judgement, experience, and an understanding of the factors that contribute to the integrity of a site and to the conservation status of a species or habitat.

5.1.3 In defining and making recommendations for appropriate measures to address significant effects their deliverability should be considered, along with certainty about their likely success. Measures which are unlikely to be successful (probability estimated at below 50%) should not be included. Rather, certain/near-certain (probability estimated at 95% chance or higher) or probable (probability estimated above 50% but below 95%) measures should be recommended. For measures for which the success is regarded as 'probable', recommendations for monitoring/corrective action are likely to be appropriate.

5.1.4 Recommendations about timing of mitigation/compensation/enhancement measures should be made where these are relevant to the likely effectiveness of the proposed measures to address predicted adverse effects.

5.1.5 Where there remain significant ecological effects that it is not possible to reduce below the level of significance by mitigation, compensation or enhancement will be provided.

5.1.6 Proposals for enhancement and measures designed as compensation for residual effects are sometimes confused. They are distinct, in that appropriate compensation measures should address specific residual impacts and should be designed to provide, as far as possible, direct replacement of any habitats lost. In contrast, enhancement measures could be entirely unrelated to any adverse effects of the Proposed Scheme.

5.1.7 Planting provided for the primary purpose of landscaping should also be reported as compensation where its provision is also of ecological benefit.

5.1.8 Overall, in line with Government policy, the project is seeking to achieve no net loss in biodiversity at the route-wide level.

5.2 Location of compensation/enhancement provision

5.2.1 The provision of mitigation, compensation and enhancement required to address the effects of the Proposed Scheme will primarily be reported at the level of the individual CA reports (Volume 2 of the ES). Where possible compensation and enhancement will be provided in accordance with CIEEM guidance in relation to ecological equivalence and location. However, such provision will not necessarily be provided within the same CA as the adverse effects occurred, where greater ecological benefits can be achieved by pooling habitat creation or providing in another location. In such circumstances, compensation/enhancement provisions should be described in the CA in which the provision will be made. They should then be cross-referenced in the mitigation, compensation and enhancement section of the CA where the effect occurred, in order to ensure that the reasoning for residual effects is clear.

6 Residual effects

6.1 Introduction

6.1.1 Following the description of all mitigation, compensation and enhancement measures proposed, the residual effects section will consider the net effects of the Proposed Scheme once these measures have been implemented.

6.1.2 Significant effects on habitat types which are considered irreplaceable (e.g. ancient woodland) should be listed as a significant residual effect even where compensation or enhancement is proposed. In such cases the loss of irreplaceable habitat should be identified as an adverse effect. Where compensation has been provided to address this effect then a corresponding 'beneficial' effect (and a geographic level of significance) may be identified for any compensation/enhancement provision proposed to offset the losses.

6.1.3 This approach is likely to be used mainly for impacts of the Proposed Scheme on ancient woodland. It is intended to reflect the view that some habitats (e.g. ancient woodland) and features are irreplaceable and as such cannot be offset on a 'like for like' basis. In this instance the 'beneficial' effect will be included to demonstrate the positive value of the proposed compensation, acknowledging that new habitat cannot replace ancient woodland.

6.1.4 For all other significant effects identified prior to the incorporation of mitigation, compensation and enhancement, consideration should be given as to whether the proposed measures are sufficient to offset effects. Where this is the case these effects will be considered to have been addressed, and no significant residual effect will be reported. Where mitigation, compensation or enhancement provision is not likely to reduce the effect below the level of significance, this will be reported as a significant 'residual effect'.

6.2 Consequences of significant residual effects

6.2.1 The consequences in legal and policy terms of significant residual effects of the Proposed Scheme will be presented within the route-wide assessment in Volume 3 of the ES. As described in the CIEEM guidelines (Section 6.1), such explicit presentation enables the decision-making body to ensure that the Proposed Scheme:

- complies with legal requirements e.g. the need to obtain a licence for any work affecting protected species or implications in respect of the Conservation (Natural Habitats) Regulations[13];
- meets international, national and local policy objectives; and
- requires conditions and legal obligations attached to the consent that deal with aspects of the detailed design and implementation of the project.

[13] *The Conservation (Natural Habitats, &c.) Regulations 1994. No. 2716*. Her Majesty's Stationery Office, London.

Appendix A: Resource evaluation criteria

Table A1: Resource evaluation criteria

Value of resource	Selection criteria
International or European	An internationally designated site or candidate/proposed site (Special Protection Area (SPA), proposed Special Protection Area (pSPA), Special Area of Conservation (SAC), candidate Special Area of Conservation (cSAC), Ramsar site or proposed Ramsar site). A sustainable area of a habitat which is significant at an international level and which is capable of meeting the criteria for designation as a site of international value. A sustainable population of a species which is significant at an international level and which is capable of meeting the relevant criteria for designation as a site of international value.
National	A nationally designated site (SSSI, NNR, Marine Nature Reserve). A sustainable area of a habitat which is significant at a national level and which is capable of meeting the criteria for designation as a site of national value. A sustainable population of a species which is significant at a national level and which is capable of meeting the relevant criteria for designation as a site of national value.
Regional	Sites/populations which exceed the county or metropolitan-level designations but fall short of SSSI selection guidelines. A sustainable population of a species which is significant at a regional level and which is capable of meeting the relevant criteria for designation as a site of regional value.
County/ metropolitan	Some locally designated sites (including Local Wildlife Sites and Sites of Metropolitan Value for nature conservation). A sustainable area of a habitat which is significant at a county level and which is capable of meeting the criteria for designation as a site of county value. A sustainable population of a species which is significant at a county level and which is capable of meeting the criteria for designation as a site of county value.
District/borough	Some designated sites (e.g. Sites of Borough Value). Sites/features which are scarce within the District/Borough or which appreciably enrich the District/Borough habitat resource.
Local/parish	Sites/populations, which appreciably enrich the immediate vicinity or parish habitat resource (e.g. moderately species-rich hedgerows) but which are not in themselves of district/borough value.
Negligible	Habitats or species populations that do not appreciably enrich the ecological value of the immediate vicinity.

Local Nature Reserves may be of value at a range of geographic levels and professional judgement should be applied based on consideration of the specific features for which the site is designated.

Appendix B: Approach to precautionary assessment

Due to access delays and refusals it will not be possible to access all areas identified as falling within the desired scope of ecology surveys. As a consequence, the EcIA will in some situations be based upon limited or incomplete data. The EcIA guidance accounts for data limitation and also makes reference to other codes of conduct, e.g. BS42020:2013 regarding data limitations.

In order to comply with requirements of the Environmental Impact Assessment Directive (85/337/EEC)[14] it is necessary for the ecology sections of the ES to identify the 'likely significant effects of the proposed project'. In order to comply with the requirements of the Directive in the absence of a full data set it is necessary to adopt a precautionary approach and attempt to identify those effects which are likely to be significant based on the available information. Case law demonstrates that it is not acceptable to simply rely upon the defence that survey work to be undertaken at a later date will identify where significant effects are likely to occur.

Baseline valuation

The level of information available to inform the valuation of ecological features within the EcIA will vary widely.

Complete access – complete field survey information available

Where full baseline information (i.e. information to the level that would typically support an ES) is available to inform the valuation process, then the standard approach to valuation as outlined within the CIEEM guidelines should be followed.

For all such valuations, ecological features should be firmly attributed to the most appropriate geographical frame of reference. The use of precautionary terminology such as 'up to' or 'likely to be' should not be utilised for the valuation of receptors that fall into this category.

[14] On 12 March 2014, the European Parliament voted to adopt substantive amendments to the Environmental Impact Assessment ("EIA") Directive 2011/92/EU. These amendments made by EIA Directive 2014/52/EU will not be transposed into UK legislation until 2017.

Partial or no access – incomplete field survey or desk study information only

Where it has not been possible to complete field survey to a level that would normally be appropriate in support of an environmental statement, then it will be necessary to make a precautionary assessment.

For habitats it is likely that it will be possible to identify potential ecological features to a reasonable level of detail through analysis of aerial photography (e.g. woodland at Location 1).

For species receptors where some field survey has been undertaken, but it is incomplete, it is likely to be possible to identify the ecological feature or potential ecological feature to a reasonable level of detail. (e.g., bat assemblage at Location 2, or potential amphibian population associated with ponds at Location 3).

Where no field survey access has been possible, in the first instance an attempt should be made to identify individual ecological features through review of aerial photography and other relevant available existing information (e.g. potential bat assemblage associated with unsurveyed woodland at Location 3).

Where this is not possible then it will be necessary to provide a collective precautionary valuation at the CA level (e.g. other bat populations within the Location 4 area).

In all such situations a precautionary valuation that represents a 'reasonable worst- case' is to be provided, i.e. one that is precautionary but it is reasonable to assume could occur, rather than an extreme scenario that is on balance unlikely. In all such cases where the baseline is incomplete the degree of precaution built into the assessment should be linked to the level of confidence in the existing data upon which the assessment is based.

For example, it is considered reasonable to assume that, within a network of partially surveyed ponds (in a locality where several small great crested newt populations have been found to occur), further populations of great crested newt may be identified, and that these would likely be of small or medium population size class. However, it would not normally be reasonable to assume that every pond where survey is incomplete is likely to support a high population of great crested newt.

For each potential receptor a reasonable worst-case valuation should be attributed based on the information available. This should include consideration of any available field or desk study data (including aerial photography), a comparison with similar habitat areas occurring in the wider local area, and a qualitative consideration against any factors that indicate suitability for the particular habitat or species in question.

In all cases throughout the paragraph and table text in the Volume 2 CA reports it should be made clear where a precautionary approach has been adopted through the use of the qualifier 'up to' alongside the relevant geographic frame of reference.

Impact assessment

Where a precautionary valuation has been made, and an effect significant at the district/borough level or higher is possible, then a description of the likely impacts as a consequence of the Proposed Scheme should be provided. The description of impacts should be as specific as the knowledge of the baseline allows. For example, it may be possible to say that a specific pond of up to district/borough value for amphibians is to be lost. However, a general statement may need to be made in relation to bats to say that activities in this area will result in the loss of trees and buildings which could support bat roosts.

The term 'could' (as opposed to 'will') is to be utilised in the assessment conclusions wherever a precautionary assessment of 'up to' X value has been necessary (e.g. this could result in an adverse effect that is significant at up to the county/metropolitan level).

Mitigation and compensation provision

For habitat losses it is likely that it will be possible to provide a clear indication as to how potential effects occurring on receptors that have not been accessed for survey will be mitigated or compensated. In most cases, as the broad habitat type will be discernible from aerial photography, it is likely that habitat losses will have been accounted for within the mitigation and compensatory provision that has been incorporated into the mitigation schedules.

For protected species, in many cases it will not be possible to specifically identify the required level of mitigation/compensation, as the exact nature of the impacts will not be discernible until it is possible to access land and gain a fuller understanding of the baseline. Therefore, a commitment will be made to providing mitigation/compensation in line with principles of mitigation for the species concerned set out in the Ecological Principles of Mitigation Technical Note.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Ecology and biodiversity – Ecological field survey methods and standards

Contents

1 Executive summary

1.1.1 This document contains methods for scoping and undertaking ecological surveys for a range of flora and fauna in support of the Proposed Scheme.

1.1.2 This document provides standard methodologies for those ecological surveys which will be conducted most frequently along the route of the Proposed Scheme in order to gather baseline information in support of the Ecological Impact Assessment (EcIA). It has been prepared after discussion with the ecological consultants commissioned to undertake field surveys. Feedback from Natural England and the Environment Agency during development of the Field Survey Methods and Standards technical notes for previous phases of HS2 has also been taken into account.

1.1.3 It is not intended to provide an exhaustive compendium of all survey methodologies utilised to inform the Environmental Statement for the Proposed Scheme. Where additional methodologies have been utilised in specific locations these details will be summarised in the ecology section of the appropriate Volume 2 Community Area (CA) reports and detailed in the Volume 5 appendices.

2 Introduction

2.1 Purpose of the technical note

2.1.1 This technical note outlines proposals for the methods and standards to be adopted for baseline ecological field surveys for the Proposed Scheme Environmental Statement (ES).

2.1.2 This document contains the methods which will be used for scoping and undertaking ecological surveys for a range of flora and fauna. It aims to ensure consistency of approach to field survey methods.

2.1.3 It has been prepared after discussion with the ecological consultants commissioned to undertake field surveys and is based on recognised best practice methods. Feedback from Natural England and the Environment Agency during development of the FSMS technical notes for previous phases of HS2 has also been taken into account. It therefore builds on the latest version of that technical note[1].

2.1.4 This document sets out the key survey methodologies and data recording requirements for those field surveys which are considered most likely to be required to inform the EcIA. It is not intended to be an exhaustive list of surveys that will be conducted. Based on the scale of the proposed works it is likely that in some locations additional surveys, not detailed here, will be required. Where further surveys are conducted these will be listed in the ecology section of the appropriate Volume 2 Community Area (CA) reports and detailed in the corresponding Volume 5 appendices of the ES.

2.2 Land required for the construction of the Proposed Scheme

2.2.1 The extent of surveys required should in all situations take into consideration the most up to date information available regarding the extent of the land required for the construction of the Proposed Scheme. For the purposes of the EcIA it is assumed that all land required for the construction of the Proposed Scheme will be lost. This assumption means that survey prescriptions within the land required have been based solely on likely ecological value of the habitats and species present, rather than likely impact.

2.2.2 As early ecological survey work commenced in spring 2017 prior to detailed engineering design, the prioritised surveys for breeding birds and great crested newts were limited to the area 500m either side of the route alignment. As more details of the Proposed Scheme design emerge, the survey extent will be widened to include a buffer from the outer

[1] High Speed Two Ltd (2017), High Speed Rail (West Midlands – Crewe), *Environmental Statement, Technical appendices: Environmental Impact Assessment Scope and Methodology Report Technical Note: Ecological field survey methods and standards (FSMS).* Available online at: https://www.gov.uk/government/publications/scope-and-methodology-report-for-hs2-phase-2a.

boundary of the land required for the construction of key elements (e.g. the operational railway, all associated infrastructure and site compounds) of the Proposed Scheme (e.g. land required + 100m). A buffer is required because effects may occur outside the area of land required for the Proposed Scheme. With each design change survey scopes must be revised, and where necessary scoping for survey requirements updated. The stability of the design must be taken into account at each location in deciding if further extension of the survey extent is necessary in order to be sure all potential significant effects are identified. Professional judgement[2] is to be used where appropriate to rationalise the requirements for survey associated with ancillary works, generally those associated with diversions to services that extend away from the route of the Proposed Scheme. For example, in some areas land could be included to facilitate such works as minor pylon realignment. Such works could extend some distance from the route of the Proposed Scheme and may be unlikely to result in significant effects on ecological receptors. As a consequence, in each case an ecologist will review the extent and nature of the works proposed and apply professional judgement to derive an appropriate survey effort for these elements of the Proposed Scheme.

2.3 Screening for survey requirements (general)

2.3.1 Ecological consultants undertaking survey work to inform the ES are expected to utilise the approach and guidance provided in this document to identify where field surveys are required and what type of survey is appropriate. Ecological expertise and knowledge of the local environment should also be utilised as appropriate.

2.3.2 Ecological field investigations should in the first instance be presumed to be required where:

- a potential ecological receptor is confirmed or it is thought there is a reasonable likelihood that such a receptor may be present; and
- significant effects on ecological integrity or conservation status may arise from the construction or operation of the Proposed Scheme.

2.3.3 Where access is available the presence of existing ecological data (either from biological records centres or pre-existing survey reports) should only be utilised to preclude the requirement for surveys specifically in support of the Proposed Scheme where:

- it is clear that the survey methodology utilised is consistent with that proposed in this document and the data available; and
- the pre-existing data set is sufficiently up to date to still be considered valid (refer to the Scope and Methodology Report (SMR)).

2.3.4 In all such cases a precautionary approach should be adopted and field survey repeated where there is any doubt over the validity of existing data.

[2] Current industry definition from Biodiversity – Code of practice for planning and development BS 42020:2013 is: Use of accumulated knowledge and experience in order to make an informed decision that is clearly capable of being substantiated with supporting evidence.

2.3.5 Where surveys in support of another development (independent of the Proposed Scheme) require survey of the same areas of land, the sharing of survey data may be required (e.g. to limit disturbance to a great crested newt breeding pond as a consequence of multiple surveys of the same water body). In all such cases, where there is a requirement to share data, consultants should liaise with the other developers' ecologists to ensure that the methods utilised are consistent with those specified in this document.

2.3.6 Due to the design evolving the required extent of surveys will vary over the period that surveys will be undertaken. Survey buffers established from the boundary of the land required for the construction of the Proposed Scheme will help to limit the impact of design changes, as the majority of changes are likely to lead to extensions into areas which already fall within the required scope of surveys.

2.3.7 Where a documented screening/scoping exercise has been conducted, and the outcome indicates that significant adverse effects on a potential ecological receptor are not likely to occur, reduced field survey effort, or scoping is likely to be appropriate. Any proposed reductions in scope will require approval from HS2 Ltd.

2.3.8 Care should be taken to ensure that receptors potentially subject to indirect effects are also included within the survey scope. An example is areas distant from the route of the Proposed Scheme which are potentially subject to impacts arising from hydrological changes. Potential indirect effects should be discussed with the relevant cross-disciplinary environmental team, as appropriate.

2.4 Safety

2.4.1 Safety is one of HS2 Ltd.'s core values. The safety of the workforce and the public is paramount. Consultants undertaking field survey will be required to ensure that a health and safety risk assessment is in place prior to commencement of each field survey visit and to satisfy themselves that all appropriate access provisions are made.

2.4.2 All risk assessments should address key health and safety issues such as potential for slips, trips and falls; working in close proximity to water; working within fields occupied by livestock; working at height; potential exposure to asbestos; confined spaces and night time working. In particular, lone working is to be avoided at all times. During the Covid-19 pandemic the Chartered Institute of Ecology and Environmental Management (CIEEM) guidance was followed to ensure that surveys were only undertaken when they could be done safely[3].

2.4.3 It is recognised that survey methods may need to be modified in some areas to allow surveys to be conducted safely, for example works on or near highways and railroads, or

[3] Chartered Institute for Ecology and Environmental Management (2020), *Guidance on Ecological Survey and Assessment in the UK During the Covid-19 Outbreak (version 3)*.

inspections of structurally unstable buildings. All such deviations should be agreed with HS2 Ltd in advance of works, and a record of all deviations should be kept.

2.5 Access to land

2.5.1 All access to undertake field surveys will be organised by the Site Access, Land Referencing and Stakeholder Engagement team. A protocol for requesting and reporting upon access will be prepared and provided to consultants undertaking survey work.

2.5.2 Consultants undertaking survey work will be briefed on the acceptable use of Public Rights of Way (PRoW) during surveys.

2.6 Biosecurity

2.6.1 Field surveyors are to take all reasonable measures to ensure compliance with best practice guidelines for preventing the spread of disease and of invasive species of flora and fauna.

2.6.2 This is particularly true of work in water. Current best practice bio-security measures are to be taken throughout, with disinfection of footwear and equipment between surveys, where they are used on more than one watercourse or water body. All amphibian surveys are to follow the guidelines for amphibian survey bio-security as set out in ARG-UK Guidance Note 4 (2010)[4] as well as Check Clean Dry guidance from the Non Native Species Secretariat website[5].

2.7 Invasive non-native species

2.7.1 Where any animals which are not ordinarily resident in Great Britain and are not a regular visitor to Great Britain in a wild state, or is listed in Schedule 9 of the Wildlife and Countryside Act 1981[6] are captured during the surveys in support of the project (in line with legislation) they will not be released back into the wild.

2.7.2 Where such species are encountered (but not captured) during surveys the species and location will be recorded. EU Regulation 1143/2014 on Invasive Alien Species[7] should be

[4] ARG-UK (published 2010, modified 31st March 2017) *ARG-UK Advice Note 4: Amphibian disease precautions: a guide for UK fieldworkers.* Available online at: http://www.arguk.org/info-advice/advice-notes/324-advice-note-4-amphibian-disease-precautions-a-guide-for-uk-fieldworkers-pdf-2.

[5] GB Non-native species secretariat. Available online at: http://www.nonnativespecies.org/checkcleandry/.

[6] *Wildlife and Countryside Act 1981 (Variation of Schedule 9) (England and Wales) Order 2010,* Her Majesty's Stationery Office.

[7] European Commission (2014), *EU Regulation 1143/2014 on Invasive Alien Species.* Available online at: http://ec.europa.eu/environment/nature/invasivealien/index_en.htm.

followed and animals will need to be humanely euthanized using an accepted method unless the surveyors are aware of opportunities for these animals to be taken into captivity.

2.7.3 Where plant species occurring on Part 2 Schedule 9 of the Wildlife and Countryside Act 1981 (as amended) are encountered during habitat surveys the species, location and extent will be recorded.

2.8 Competency standards

2.8.1 Field surveyors must meet the minimum relevant CIEEM Competency for Species Survey (CSS) standards[8] that apply where these are available. The use of the word 'competent' in this document means a sufficient level of expertise and experience to undertake the survey to the required standard.

2.9 Combining surveys

2.9.1 Although the methodologies for the various surveys are described separately in this document, there is clearly scope for combining surveys and particularly screening to confirm the need to undertake specialist surveys.

2.9.2 Whilst combining surveys is encouraged where it is practical, it should not take place where this would result in a lack of adequate focus on particular surveys.

2.10 Identification of potential mitigation areas and receptor sites

2.10.1 During the process of screening and conducting field surveys consultants should consider the potential suitability of land within the vicinity of the prescribed survey extents to be utilised to provide mitigation or compensation, including use as receptor sites for protected species translocated from habitats lost as a consequence of the Proposed Scheme. This will assist in the development of mitigation and compensation measures.

2.11 Compliance and variations

2.11.1 Consultants undertaking field surveys should comply with the methods within this document, with deviations only permitted with approval from HS2 Ltd.

2.11.2 It is recognised that limitations in relation to access and health and safety may require a variation in survey scope and method as identified in 2.4.3.

[8] Chartered Institute of Ecology and Environmental Management (2013), Competencies for species surveys in Britain and Ireland.

2.11.3 Access and timing restrictions beyond the control of the consultants may reduce the amount of survey that can be undertaken in some locations. A precautionary approach to assessment will be adopted in such circumstances.

2.11.4 It is also recognised that in some areas (particularly suburban and urban areas), it will be appropriate to reduce the spatial scope defined in this document to reflect the fact that any potential significant effects in such areas are likely to be more closely associated with the route of the Proposed Scheme. For example, in urban or suburban areas where large numbers of residential dwellings (which are to be retained) are present within the standard survey buffer, it is not anticipated that all such buildings will require internal inspection for bats.

2.11.5 In these situations, suitably qualified consultants undertaking field surveys are expected to make professional judgements regarding the required spatial scope on a site by site basis and record the rationale for these decisions. All such deviation requests will need to be agreed by HS2 Ltd.

3 Survey referencing and recording - general approach

3.1 Survey referencing

3.1.1 The location of all ecological survey information that is collected is to be identified by a reference number for use on project mapping and within Geographical Information Systems (GIS). This number begins with the land title reference (e.g. GM123456), followed by the licence number (e.g. L1234). These numbers are followed by the survey type code as set out in table 1, a feature number (e.g. the number of a target note), and the date in the format ddmmyy. An example for a Phase 1 survey would be GM123456_L1234_PH1_120917. For a target note taken on that survey the reference number would be GM123456_L1234_PH1_F003_120917. Additionally, letters are used to denote photos (p), forms (f) and maps (m).

Table 1: Survey type codes

Survey	Survey type code
Amphibian - Aquatic survey (during mid-March to mid -June)	AA1
Amphibian - Aquatic survey outside of the period mid-March to mid-June	AA2
Amphibian – Habitat Suitability Index (HIS)/walkover	AH1
Amphibian - Terrestrial survey (refuges only)	AT1
Amphibian - Terrestrial survey (temporary amphibian fencing and pitfall traps/refuges)	AT2
Badger - Field survey for signs of activity	BD1
Badger - Extended field survey in support of territory analysis	BD2
Badger - Field survey in support of bait marking exercise	BD3
Bat - Initial assessment of structures including buildings, bridges and caves	BS1
Bat - Further inspection of structures including buildings, bridges and caves	BS2
Bat - Emergence survey of structures including buildings, bridges and caves	BS3
Bat - Initial assessment of trees	BT1
Bat - Further inspection of trees	BT2
Bat – Emergence survey of trees	BT3
Bat - Activity (transect)	BA1
Bat - Activity (static detector)	BA2
Bat - Activity (swarming)	BA3
Bat - Activity (mist net/harp trapping/radio tracking)	BA4
Bat – Hibernation	BH1
Breeding bird - Discrete area/Common Birds Census	BB1
Breeding bird – Habitat sampling	BB2
Breeding bird - Species specific	BB3
Ditch vegetation survey	DS1

Survey	Survey type code
Fish survey	FI1
Hazel dormouse – Habitat appraisal	HD1
Hazel dormouse – Nest tube survey	HD2
Hazel dormouse – Nut search	HD3
Hedgerow survey	HS1
Invertebrates - Aquatic survey	IA1
Invertebrates - Terrestrial survey	IT1
Otter – Habitat appraisal	OT1
Otter – Detailed survey	OT2
Pond survey (Rapid assessment method)	PS1
Pond survey (Predictive System for Multimetrics)	PS2
Pond survey (National Pond Survey)	PS3
Reptiles – Habitat appraisal	RE1
Reptiles – Detailed survey	RE2
River Corridor Survey	RS1
River Habitat Survey	RS2/RH1
Scoping survey	SCO
Water vole- Habitat appraisal	WV1
Water vole – Detailed survey	WV2
White-clawed crayfish – Habitat appraisal	WC1
White-clawed crayfish – Manual search	WC2
White-clawed crayfish – Trapping survey	WC3
Wintering and passage birds – General	WB1
Wintering and passage birds - Species specific	WB2
Phase 1 habitat survey – Habitat parcel/feature	PH1
Vegetation (Phase 2 – National Vegetation Classification survey)	PH2

3.1.2 Where multiple survey visits are required at a discrete location (e.g. six amphibian visits to the same pond) then the results of all visits will be recorded under the single reference code for this survey location.

3.1.3 Note that for badgers each sett should be allocated a feature number. Where other field signs are identified away from a sett (e.g. latrine, hair on fence of badger path) these should be allocated a separate feature number.

3.2 Survey Proformas

3.2.1 Data for each type of survey should be submitted on the relevant, approved proforma with supporting maps and documentation. Care should be taken to ensure that the proformas are used correctly and that all the required information is provided.

4 Phase 1 (extended) habitat survey

4.1 Introduction and guidelines

4.1.1 The methods to be used to map the habitats and vegetation present along the route of the Proposed Scheme are set out below. A standard Phase 1 habitat survey may be sufficient in some circumstances as detailed in Sections 4.4 and 4.5 below. However, as the Phase 1 habitat survey is often the first opportunity to visit the route a Phase 1 (extended) habitat survey may be appropriate which includes the requirement to search for and record signs of protected or otherwise notable species, and to assess habitats for their potential to support protected or otherwise notable species, as well as invasive species of flora and fauna. This information will be used as part of the decision process for targeting future surveys.

4.2 Qualifications and experience

4.2.1 Surveyors are to be competent in Phase 1 habitat survey, be competent botanists and have previously undertaken surveys of the types of habitats likely to be present. For extended Phase 1 habitat survey, surveyors will also be competent in the identification of potential for habitats to support protected or otherwise notable species (e.g. badger, otter, hazel dormouse and bats).

4.3 Licensing requirements

4.3.1 There are no licensing requirements for Phase 1 habitat survey.

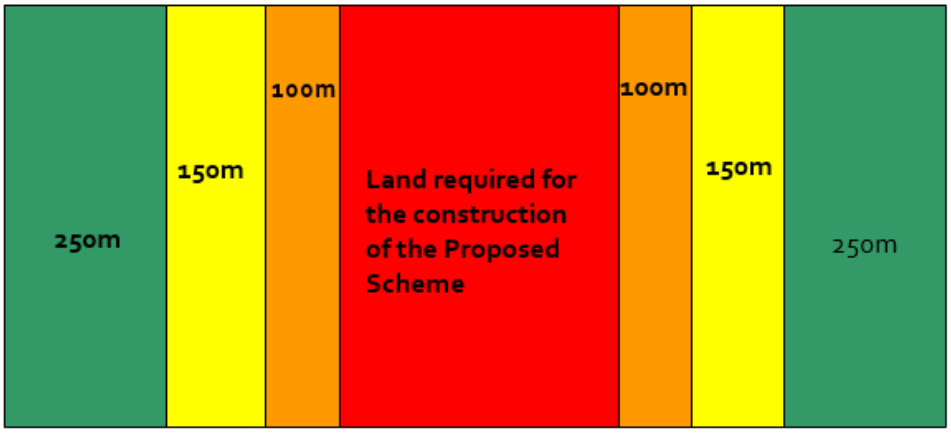
4.4 Screening for survey and defining the survey area

4.4.1 Phase 1 habitat mapping is required for the entire route of the Proposed Scheme within the survey buffers defined below.

4.4.2 As a minimum (subject to the caveats identified in Section 2.11) consultants are required to produce a set of route maps identifying habitat types within the land required for the construction of the Proposed Scheme and within a 500m buffer either side of it. The level of field survey required is not the same across the whole of the additional 500m buffer either side of the land required, but is zoned according to likely impacts, as described below.

4.4.3 Figure 1 below shows the standard division of zones within the 500m buffer beyond the boundary of the land required for the construction of the Proposed Scheme.

Figure 1: Standard extents of Phase 1 habitat survey



4.4.4 In rural areas, within the land required for the construction of the Proposed Scheme and 100m either side, the level of survey should, as a minimum, follow the full, extended Phase 1 habitat survey method.

4.4.5 From 101m to 500m from the boundary of land required for the construction of the Proposed Scheme the habitats will be mapped from aerial photograph interpretation alone and there will be no requirement to undertake a field-based Phase 1 habitat survey. However, where possible a note should be made of any obvious changes in habitat type from that shown from interpretation of aerial photographs e.g. woodland felled; hedgerow removed; improved grassland now under arable cultivation.

4.4.6 In urban areas the survey zones are likely to be restricted in extent and for many areas limited to the route and areas with public access. Where feasible, up to 100m from the route, the level of survey should follow the full extended Phase 1 habitat survey method but as a minimum, a note should be made of any obvious changes in habitat type from that shown from interpretation of aerial photographs.

4.4.7 Following initial site visits and mapping it may be necessary to revisit and modify the survey zones locally in order to capture sufficient information to inform the scope of other investigations and assess likely significant effects. For example, the 100m survey zone may be expanded to include the whole of a sensitive habitat that is within, but extends beyond the 100m zone described above. Target notes should highlight landscape connectivity - for woodlands, hedgerows, scrub and trees

4.4.8 The approach described shall be principally applied in relation to the land required for the construction of the key elements (e.g. the operational railway, all associated infrastructure, site compounds and storage areas) of the Proposed Scheme.

4.4.9 Professional judgement should be used where appropriate to rationalise the requirements for survey associated with ancillary works, generally associated with diversions to services that extend away from the route of the Proposed Scheme.

4.5 Survey methods

4.5.1 The survey is to be undertaken following the published methodology for Phase 1 habitat survey[9] and Guidelines for Preliminary Ecological Appraisal[10]. This includes mapping the habitat type according to the definitions in the Handbook for Phase 1 habitat survey (Joint Nature Conservation Committee, 2010); noting dominant species; and providing target notes where appropriate to identify particular features/species.

4.5.2 Particular care is required with distinguishing unimproved neutral grasslands from semi-improved grasslands. Survey in late May to the end of June for these habitats can minimise the risk of wrongly ascribing unimproved neutral to semi-improved grassland.

4.5.3 Where available, a GIS based digital map is to be used as the base map for recording habitats in the field.

4.5.4 For the area within the land required for the construction of the Proposed Scheme and the 100m buffer zone the information required from the extended Phase 1 habitat survey should be sufficient to assess the requirements for further survey (e.g. National Vegetation Classification and protected species surveys). The consultants undertaking field survey are to determine whether such surveys could be required in the wider buffer zone further than 100m from the land required for the construction of the Proposed Scheme. This is to be decided on the basis of the value and sensitivity of the habitat and its associated species and the potential for effects to occur in this area.

4.5.5 Target notes should be used to identify modified habitats such as areas of low diversity/value road verge grasslands, to distinguish them from unimproved or other higher value habitats.

4.5.6 Invasive plant species such as Japanese knotweed are to be mapped as 'tall ruderal' with associated target notes.

4.5.7 Extended Phase 1 habitat survey includes the recording signs of and suitability for protected/notable species according to methods in Guidelines for Baseline Ecological Assessment[11]. Such signs and features should be accurately located on a plan and GPS coordinate(s) recorded.

4.5.8 Where no access is available for survey, any existing desk study data and a review of aerial photography should be used to allocate areas to Phase 1 habitat codes.

[9] Joint Nature Conservation Committee (2010), *Handbook for Phase 1 habitat survey - a technique for environmental audit.* Peterborough.

[10] Institute of Ecology and Environmental Management (2012), *Guidelines for preliminary ecological appraisal.*

[11] Institute of Environmental Assessment (1995), *Guidelines for Baseline Ecological Assessment*. E and FN Spon, London.

4.6 Survey programme and effort

4.6.1 Plant species associated with different habitats are more easily identified at various times in the growing season. In order to identify most habitats accurately, Phase 1 habitat survey should ideally be undertaken between April and early October. However, in order to prevent delay in the identification of protected species constraints, in all cases Phase 1 habitat survey should be completed as early as access is forthcoming and repeated during the following optimum window for habitat survey where required.

4.6.2 For some habitats of low intrinsic ecological value (e.g. areas dominated by amenity grassland, hard standing or buildings), it will be possible to gather sufficient information of value outside the April to early October window and no repeat survey will be required.

5 National Vegetation Classification survey

5.1 Introduction and guidelines

5.1.1 Habitats identified at the Phase 1 stage as being particularly species diverse and/or sensitive, of a type restricted in the UK/Region and which could be directly or indirectly affected by the Proposed Scheme are likely to require further survey to Phase 2 National Vegetation Classification (NVC) level.

5.1.2 Where it is identified that Phase 2 (NVC) surveys are required, the survey methods are as a general rule to follow the published methodology appropriate to the vegetation being surveyed[12,13].

5.1.3 Reference should also be made to National Vegetation Classification: User's Handbook[14] and the web site of the Joint Nature Conservation Committee[15] , where up-to-date information can be obtained regarding changes/additions to the vegetation types presented in the original published volumes.

5.1.4 It is acknowledged that in some habitats NVC may not represent the most appropriate method of Phase 2 vegetation survey to provide quantitative data in support of impact assessment (e.g. for open mosaic habitats). In all such cases a deviation request should be submitted to HS2 Ltd.

5.2 Qualifications and experience

5.2.1 Surveyors are to be competent botanists who can recognise plants that are not in flower and the species of plant critical to the habitat type(s) in question. They should be competent in undertaking Phase 2 (NVC) surveys across the range of habitats likely to be encountered.

5.3 Licensing requirements

5.3.1 There are no licensing requirements for Phase 2 (NVC) survey.

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[12] Rodwell, J.S. (1991), *British Plant Communities*, Publication in Five Volumes. Cambridge University Press. Cambridge.

[13] Rodwell, J.S. (2006), *National Vegetation Classification: User's handbook*, Joint Nature Conservation Committee. Peterborough. Available online at: http://jncc.defra.gov.uk/pdf/pub06_NVCusershandbook2006.pdf.

[14] Rodwell. J.S., Dring., J.C., Averis, A.B.G., Proctor, M.C.F., Malloch, A.J.C., Schaminee, J.H.J. and Dargie, T.C.D. (2000), *Review of coverage of the National Vegetation Classification*, Joint Nature Conservation Committee, Peterborough.

[15] Joint Nature Conservation Committee. *National Vegetation Classification (NVC).* Available online at: http://jncc.defra.gov.uk/page-4259.

5.4 Screening for survey and defining the survey area

5.4.1 The results of the desk study and/or the Phase 1 habitat survey should be used along with consideration of the nature, location and extent of the habitat within the land required for the construction of the Proposed Scheme and surrounding land to identify areas for survey to NVC level.

5.4.2 Habitats that are likely to require survey at Phase 2 include ones where there are:

- potential significant direct or indirect effects on designated statutory and non- statutory wildlife sites;
- potentially significant effects on habitats of principal importance identified within Section 41 of the Natural Environment and Rural Communities (NERC) Act (2006)[16]. As a guide, areas of greater than 1ha in area are more likely to require NVC survey but the consultants undertaking field survey should decide whether areas smaller than this should also be surveyed on a case-by-case basis depending on habitat quality and complexity. It should be noted that even where significant effects are anticipated NVC survey will not be appropriate for all extents of habitats of principal importance (e.g. reedbed);
  - potential significant direct effects on other habitats considered to be particularly high quality/value examples of their type or likely to contain uncommon plant species;
  - potential indirect impacts on extensive wetland areas; and/or
  - ancient woodlands.

5.4.3 Where the habitat being surveyed extends beyond the land required for the Proposed Scheme and its 500m buffer, for example where there are large woodland blocks, comparative data are likely to be required from the wider area to enable an assessment of the scale of impact from the development. This will be decided on a case-by-case basis by the consultants undertaking the survey.

5.5 Survey method

5.5.1 At each site identified for survey, homogenous stands of vegetation are to be identified and sampled with a minimum of five quadrats, size appropriate to the vegetation being surveyed (see Rodwell 1991 et seq. or Rodwell, 2006). Following the standard NVC approach, representative quadrats are to be recorded in homogenous stands of vegetation.

5.5.2 Where woodland is encountered and is directly impacted by the route, it is expected that NVC level data will be collected where it is either ancient woodland or semi-natural woodland where the number of ancient woodland indicator species is considered to be high

[16] *Natural Environment and Rural Communities Act (1996),* Chapter 16. Her Majesty's Stationery Office, London.

enough to warrant detailed survey. Guidance for sampling woodlands is given in Rodwell (2006). Within small woodland blocks it is likely that five 50m x 50m samples cannot be taken and the whole stand can be the quadrat for canopy and understorey but within such areas replicate 4m x 4m or 10m x 10m quadrats can be recorded for the field and ground layers and then combined.

5.5.3 Within each quadrat all species are to be recorded with an estimate of percentage cover/abundance using the Domin scale (1 = few individuals; 2 = some individuals; 3 = many individuals; 4 = 4% - 10%; 5 = 11% - 25%; 6 = 26% - 33%; 7 = 34% - 50%; 8 = 51% -75%; 9 = 76% - 90%; 10 = 91% - 100%). Subsequent areas of the same vegetation within a site do not require five additional quadrats but should be sampled for consistency and at least one quadrat recorded and, based on size, possibly more at the discretion of the surveyor.

5.5.4 As well as recording the cover/abundance of species, additional data to be recorded include the area of bare ground, average sward height (for grasslands) and cover of leaf litter (woodlands).

5.5.5 The location of each quadrat should be recorded accurately on a plan and a GPS coordinate taken.

5.5.6 Voucher specimens should be taken for species for which identification may be contentious, including some bryophytes and lichens.

5.5.7 A sketch plan of the whole area surveyed should be made and a record made of physical parameters including slope and aspect (see Rodwell, 2006) where necessary to allow assessment of significant effects. Consultants undertaking field surveys should also consider whether pH and soil depth data are required to assess effects on the vegetation.

5.6 Data analysis

5.6.1 The data collected is to be analysed to provide the 'best' approximation to a published NVC type.

5.6.2 The data recorded in the quadrats from each homogenous stand of vegetation are to be tabulated and a constancy value for each species calculated for each defined group of quadrats, as follows:

- Scale: I = 1% - 20%. II = 21% - 40%. III = 41% - 60%. IV = 61% - 80%. V = 81% -100.

5.6.3 The tables produced will then be used to assign the vegetation types to one of the published plant community types through use of the keys provided in the published volumes and by visual comparison of the collected data with the published data. In addition, there are also computer programs (MATCH or TABLEFIT) that can be used to facilitate comparison of the data sets with published data. Alternative software should not be utilised without prior approval.

5.7 Survey programme and effort

5.7.1 The accurate definition of plant communities requires comprehensive species lists, including grasses and lower plants. As far as possible, Phase 2 surveys should therefore take place when most species and particularly any characteristic species, are at their most visible. For most habitats, this will cover the period May to July.

6 River Habitat Survey

6.1 Introduction and guidelines

6.1.1 River Habitat Survey (RHS) is a method designed to characterise and assess, in broad terms, the physical structure of freshwater streams and rivers.

6.1.2 The proposed approach will follow the survey methodology outlined within River Habitat Survey in Britain and Ireland; Field Survey Guidance Manual; Version 3 (Environment Agency, 2003)[17]. River Corridor Survey (RCS) may also need to be conducted on the same sections of watercourse where this is likely to add to the identification of significant ecological receptors.

6.1.3 RHS is carried out along a standard 500m length of river channel. Observations are made at ten equally spaced spot-checks along the channel, whilst a sweep-up along the whole 500m at the end of the survey includes features not occurring on the spot-checks. Information on valley form and land-use in the river corridor provides additional context.

6.2 Qualifications and experience

6.2.1 All initial scoping and subsequent field survey should be conducted by competent surveyors who have attended training in the 2003 Version of the Environment Agency methodology and passed an accreditation test.

6.3 Licensing requirements

6.3.1 There are no licensing requirements for RHS.

6.4 Screening for survey and defining the survey area

6.4.1 The desk study will identify watercourses identified by the Environment Agency as 'main' rivers and the results of the Phase 1 habitat survey will indicate the nature of any other watercourses. Lengths of a watercourse should be surveyed if:

- the watercourse is defined as 'main' river; or
- the watercourse has flowing water and a channel width of more than 1m;
- the watercourse is not obviously canalised or heavily managed; and

[17] Environment Agency (2003), *River Habitat Survey in Britain and Ireland. Field Survey Guidance Manual;* 2003 Version. Environment Agency.

- the watercourse is to be lost/culverted/diverted or potentially experience a significant change in water quality or quantity that could affect the flora and fauna within the watercourse and/or designated wildlife sites downstream.

6.4.2 At each location selected for survey the survey will as a minimum cover a 500m section of the watercourse centred on the centreline of the route of the Proposed Scheme (i.e. 250m either side of the route). Consultants undertaking survey should consider the need to extend this to incorporate further 500m sections at those locations where this extent does not include as a minimum the land required for the construction of the Proposed Scheme and a 100m buffer either side of the boundary of the land required, or watercourse diversions are proposed and there is considered to be the potential for likely significant effects further upstream or downstream.

6.5 Survey Methods

6.5.1 The survey should be undertaken according to the methodology provided in River Habitat Survey in Britain and Ireland; Field Survey Guidance Manual; Version 3 (Environment Agency, 2003).

6.5.2 Results should be recorded using the standard 2003 Version survey forms with the survey unique reference recorded (following the conventions shown in Section 3) within the survey number/site reference fields.

6.5.3 GPS coordinates are to be recorded at the beginning and end of each survey section.

6.5.4 River Macrophyte surveys should follow the WFD UKTAG River Assessment method[18]. Relevant macrophyte surveys are also to be obtained from the Environment Agency where available.

6.6 Survey programme and effort

6.6.1 Where possible RHS surveys should be undertaken during the months of May or June, in order to avoid vegetation obscuring channel features. Where emergent and bankside vegetation is limited, or regularly managed then survey may be suitable over a much longer season. Where surveys are undertaken outside of the non-optimal months of May and June, subsequent interpretation of the results should take into account the seasonal aquatic and bankside vegetation growth (Environment Agency, 2003).

6.6.2 High water levels and turbidity will also obscure many of the features RHS is designed to record (Environment Agency, 2003). Survey should therefore not be conducted following periods of heavy rain and should be delayed until water level and turbidity have returned to acceptable levels.

[18] Water Framework Directive – United Kingdom Advisory Group (WFD-UKTAG) (2014), *UKTAG River Assessment Method Macrophytes and Phytobenthos (River LEAFPACS2).* Stirling. ISBN:978-1-906934-44-6.

7 Hedgerow survey

7.1 Introduction and guidelines

7.1.1 The survey of hedgerows may be undertaken concurrently with the Phase 1 habitat survey but there are specific details to record over and above that usually recorded at Phase 1 level.

7.1.2 Please refer to the Hedgerows Regulations (1997)[19] for the full definition.

7.2 Qualifications and experience

7.2.1 Surveyors are to be competent botanists, able to identify woody hedgerow species and associated woodland ground flora.

7.3 Licensing requirements

7.3.1 There are no licensing requirements for hedgerow survey.

7.4 Screening for survey and defining the survey area

7.4.1 All hedgerows that fall within or partly within the land required for the construction of the Proposed Scheme are to be surveyed to comply with the requirements of the 'Wildlife and Landscape Criteria' in the Hedgerows Regulations (1997). Survey should not be limited to just those hedgerows that are more than 30 years old. However, hedgerows that have obviously been recently planted (e.g. tree guards and stakes still present) may be excluded.

7.4.2 It is recognised that full surveys for all potential fauna species are unlikely to be necessary for all hedgerows; assessment and requirements for further survey is to be based upon the desk-study results and outcomes of the habitat appraisal for protected and notable species.

7.4.3 Where a hedgerow within the land required for the construction of the Proposed Scheme is a priority habitat, the survey should continue to the 100m buffer limit.

7.4.4 Hedgerows more than 100m from the boundary of the land required for the construction of the Proposed Scheme are unlikely to require full survey. Location of hedgerows will be captured by Phase 1 habitat survey conducted from aerial photographs. Where possible field surveys should seek to confirm that these hedgerows remain present.

[19] *The Hedgerows Regulations (1997).* SI1997 No 1160. Her Majesty's Stationery Office.

7.5 Survey method

7.5.1 Surveys should comply with the requirements of the 'Wildlife and Landscape Criteria' in the Hedgerow Regulations (1997).

7.5.2 Depending on length, this involves recording the number of woody species along at least one typical 30m section and recording associated data including hedgerow height and width, number of mature trees and the presence of ditches or banks.

7.5.3 The start and end points of each hedgerow are to be recorded with at least an 8 figure OS grid reference using GPS.

7.5.4 The total number of other hedgerow connections to the hedgerow being surveyed should also be recorded, as recommended in the Defra Hedgerow Survey Handbook (Defra, 2007)[20].

7.5.5 Hedgerows are to be recorded and mapped with a unique ecology survey code attributed, following the general description given in Section 3. It is helpful to map hedgerows from aerial photography in advance of survey so that survey sections and nodes can be identified.

7.6 Survey programme and effort

7.6.1 The optimal time to carry out hedgerow survey is between April and September when the woody vegetation and ground flora is most easily identifiable.

[20] Department for Environment, Food and Rural Affairs (2007), Hedgerow Survey Handbook. A Standard Procedure for local survey in the UK. Defra, London.

8 Ditch vegetation survey

8.1 Introduction and guidelines

8.1.1 The method to be used to survey the vegetation of ditches is that published in A Manual for the Survey and Evaluation of the Aquatic Plant and invertebrate Assemblages of Grazing Marsh Ditch Systems Version 6[21]. This is based on an earlier methodology[22].

8.1.2 This methodology has been utilised to provide a uniform approach to obtaining data.

8.1.3 It is acknowledged that the method was devised for use in coastal and floodplain grazing marsh ditches and as such the evaluation of conservation value will not use the criteria which form part of the methodology.

8.1.4 The methodology for the selection and sampling of ditches for invertebrate assemblages is provided in Section 19.

8.2 Qualifications and experience

8.2.1 Surveyors are to be competent botanists and experienced in undertaking standardised vegetation surveys.

8.3 Licensing requirements

8.3.1 If a survey is to be carried out on a site where a plant protected by listing on Schedule 8 of the Wildlife and Countryside Act 1981 has been recorded (e.g. *Alisma gramineum, Leersia oryzoidies, Luronium natans)* a licence may be needed. Screening for survey and defining the survey area.

8.3.2 The results of the Phase 1 habitat survey will indicate the nature of ditches. The surveyor is to judge whether a ditch requires additional survey work in order to assess significant effects. As a guide, further survey is likely to be required where a ditch:

- is likely to hold permanent water; and
- has not been heavily managed, e.g dredged;
- supports a diverse and/or otherwise notable aquatic, emergent and marginal flora that cannot be adequately described by Phase 1 habitat survey; and

[21] Palmer M., Drake CM. and Stewart N. (2013), *A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems*, Version 6. Buglife, Peterborough.

[22] Alcock, M.R. and Palmer, M.A. (1985), *A standard method for the survey of ditch vegetation CST Notes No.37*. Nature Conservancy Council, Peterborough.

- is likely to be subject to significant effects due to habitat loss/culverting/diversion or experience a significant change in water quality or quantity.

8.3.3 The requirement for survey is likely to be limited to ditches that fall within or partly within the land required for the construction of the Proposed Scheme and surrounding 100m buffer. Only in exceptional circumstances is it envisaged that survey will be required beyond the 100m buffer. This is most likely to be where the ditch network is extensive and part of a large wetland complex. Where there is a complex of ditches, more extensive survey may be required (at least 20% of ditches) to assess effects on to the wider network, though sampling rather than survey of every ditch may be sufficient. Professional judgement is to be made by the surveyors on a case-by-case basis.

8.4 Survey method

8.4.1 A representative 20m section of ditch is chosen for the detailed survey described below and the whole ditch (as far as access allows) should be surveyed to list plant species. If the nature of the ditch changes, then further sections are surveyed as necessary. All plants growing in the ditch and on the banks up to the top of the bank are recorded to species level wherever possible, along with their abundance on the DAFOR scale (Dominant, Abundant, Frequent, Occasional or Rare).

8.4.2 As well as vegetation, the following parameters are measured/assessed, as described in the manual:

- adjacent land-use;
- ditch features, bank top width, freeboard, bank angles (above and below water level), water depth, silt depth, water width;
- a cross-section description (sketch);
- conductivity, pH, turbidity, water colour; and
- vegetation cover, grazing/vegetation cover, management.

8.4.3 A standard recording form is completed for each surveyed section.

8.5 Survey programme and effort

8.5.1 Where possible, ditches selected for further survey should be surveyed in the period mid-June to the end of August for ease of identification of plant species but September is also acceptable.

8.5.2 Where survey has been undertaken outside of the periods identified above the limitations should be identified and discussed to place any results obtained into context.

9 Pond survey

9.1 Introduction and guidelines

9.1.1 Methods for detailed survey of ponds are based on the methods developed by the Pond Conservation Trust (now the Freshwater Habitats Trust). Details of the methods in the National Pond Monitoring Network can be found on their website[23].

9.1.2 The method to be used will depend on the preliminary assessment from the Phase 1 (extended) habitat survey, as well as the location of the pond in relation to the route and whether the pond is to be lost. All methods involve sampling of the aquatic macro-invertebrate fauna, with some also requiring botanical survey, as well as the measurement of physical and chemical parameters.

9.2 Qualifications and experience

9.2.1 Surveyors are to be competent in undertaking aquatic macro- invertebrate surveys and in botanical identification. There is also a requirement for personnel who can identify invertebrate specimens to the taxonomic level appropriate to the method used but this does not have to be in the field and can be laboratory- based.

9.3 Licensing requirements

9.3.1 There are no licensing requirements for the pond survey unless the surveyor considers that the survey methods could affect protected species utilising the pond. e.g. collection of listed invertebrates for laboratory-based identification.

9.3.2 If a survey is to be carried out on a site where a plant protected by listing on Schedule 8 of the Wildlife and Countryside Act 1981 has been recorded (e.g. *Alisma gramineum, Leersia oryzoidies, Luronium natans*) a licence may be needed.

9.3.3 All invertebrate surveys should follow the guidelines provided by the Joint Committee for Conservation of British Insects (2002). The following legal constraints are based on Natural England research report NERR005 (2007) and should be considered when conducting surveys.

9.3.4 If a survey is planned at a site where legally protected invertebrates have been previously recorded (see the JNCC website), a license issued by the relevant statutory conservation agency is needed to collect species fully protected under the Wildlife and Countryside Act. This will also cover invertebrates listed in Annex IV of the Habitats and Species Directive and for which a license is required under European regulations.

[23] Freshwater Habitats Trust. *Survey methods*. Available online at: https://freshwaterhabitats.org.uk/projects/surveys/.

9.3.5 Legally protected vertebrates: it is an offence to collect or disturb protected species even as an incidental part of a lawful operation. A licence is needed if there is risk of capturing protected species (such as great crested newt) in pitfall and other passive open traps. A wire mesh placed over pitfall and water traps will reduce or prevent this risk, but may also reduce the catch of larger invertebrates.

9.3.6 Bye-laws and rules: capturing animals is prohibited by bye-laws and the rules of several organisations, including the Forestry Commission, Forest Enterprise, the National Trust, the Environment Agency, county wildlife trusts and local authorities (for Nature Reserves). Permission is required for surveys on sites covered by such bye-laws and rules.

9.3.7 National Nature Reserves and Sites of Special Scientific Interest: collecting on these sites is classed in England as an 'operation likely to damage'. Permission to collect must be obtained from the local office of the statutory conservation agency. Permission is unlikely to be refused for a 'bona fide' survey.

9.4 Screening for survey and defining the survey area

9.4.1 The results of the Phase 1 habitat survey will identify and provide an initial description of ponds.

9.4.2 Ponds are to be subject to further survey where a pond is likely to experience significant effects (e.g. pollution, siltation, filling in) and where the pond:

- holds water for four consecutive months or longer;
- has not been heavily managed; and
- supports a diverse or otherwise notable aquatic, emergent and marginal flora.

9.4.3 Where the pond is likely to be lost or significantly affected then it should be subject to a survey using the Predictive SYstem for Multimetrics (PSYM)[24] or National Pond Survey (NPS)[25] methodology, with the NPS method limited to ponds with the most diverse and/or notable flora and which, in the professional opinion of the surveyor, cannot be adequately assessed using PSYM. Ponds not threatened with loss and only minor effects should be subject to the rapid assessment method.

9.4.4 Ponds for survey will lie within the land required for the construction of the Proposed Scheme or within a 50m buffer. The consultant undertaking field surveys should also assess whether any ponds outside this area also need to be surveyed, based on the likelihood of significant effects.

[24] Pond Action (2002), *A Guide to Monitoring the Ecological Quality of Ponds and Canals Using PSYM*. Pond Action, Oxford.

[25] Pond Action (1998), *Guide to the Methods of the National Pond Survey*. Pond Action, Oxford.

9.5 Survey methods

Rapid assessment method

9.5.1 The rapid assessment for ponds requires invertebrate sampling only and is a rapid assessment of 'naturalness' using invertebrate diversity and families similar to the Biological Monitoring Working Party system for running water.

PSYM

9.5.2 The Predictive SYstem for Multimetrics (PSYM) method includes collection of physical data, invertebrate sampling and plant recording (Pond Action, 2002)[26]. These data are used to undertake an analysis to compare the pond against a national database held by the Pond Conservation Trust (PCT). The data are submitted to PCT for analysis.

National Pond Survey

9.5.3 The National Pond Survey (NPS) method provides the most detailed assessment of a pond and includes environmental and chemical data from the pond in addition to plant and invertebrate survey (Pond Action, 1998)[27].

9.6 Survey programme and effort

9.6.1 The survey should be undertaken in accordance with the programme recommended in the relevant survey guidelines.

[26] Pond Action (2002), *A Guide to Monitoring the Ecological Quality of Ponds and Canals Using PSYM*. Pond Action, Oxford.

[27] Pond Action (1998), *Guide to the Methods of the National Pond Survey*. Pond Action, Oxford.

10 Amphibians (great crested newt)

10.1 Introduction and guidelines

10.1.1 The Proposed Scheme has the potential to result in adverse effects on populations of amphibians as a consequence of loss and/or disturbance of breeding ponds, loss of terrestrial habitat and severance/fragmentation of habitat. Of particular importance are impacts with the potential to affect great crested newt (*Triturus cristatus*).

10.1.2 The survey approach is based on guidance provided within Great Crested Newt Mitigation Guidelines (English Nature, 2001)[28] and Natural England's European Protected Species Mitigation Licence (EPSML) application template for method statement to support application for licence under Regulation 55 (2)e in respect of great crested newts. The most up-to-date version of the template available on gov.uk should be used[29].

10.1.3 Scoping is to be undertaken using an appropriate combination of traditional survey methods and eDNA survey and analysis following the approach recommended by Natural England. This specifies that eDNA surveys can be used following the methods in the technical report that accompanies Defra's research project into eDNA and use of quantitative polymerase chain reaction testing[30].

10.1.4 The survey methods employed will vary depending on the likely impact to a population utilising the water body in question. Where initial visits and/or results of eDNA sampling and analysis confirm the presence of great crested newt, further visits should be undertaken in order to provide an estimate of the size of the population using the pond.

10.1.5 Where the seasonal timing of surveys is constrained by access, then non-standard methods (e.g. detection of larvae in late summer) will be utilised where appropriate to confirm presence; such methods should not be utilised to assume likely absence.

[28] English Nature (2001), *Great Crested Newt Mitigation Guidelines*. English Nature, Peterborough.

[29] Natural England (2012), Template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts *Triturus cristatus*. Form WML-A14-2 (Version December 2015). Available online at: https://www.google.co.uk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwik7aumv6rYAhWbHsAKHQVzAEoQFggzMAI&url=https%3A%2F%2Fwww.gov.uk%2Fgovernment%2Fpublications%2Fgreat-crested-newts-apply-for-a-mitigation-licence&usg=AOvVaw1tzr-aYc94HJRlTb_GyJng.

[30] Biggs J, Ewald N, Valentini A,Gaboriaud C, Griffiths RA, Foster J, Wilkinson J, Arnett A, Williams P and Dunn F. (2014), *Analytical and methodological development for improved surveillance of the great crested newt Appendix 5. Technical advice note for field and laboratory sampling of great crested newt (Triturus cristatus) environmental DNA.* Freshwater Habitats Trust, Oxford.

10.2 Biosecurity

10.2.1 It is essential to follow best practice biosecurity measures (see Section 2.6) to ensure no cross-contamination of water bodies.

10.3 Qualifications and experience

10.3.1 Surveyors should be competent in amphibian surveys. Surveyors carrying out torch surveys, bottle trapping, netting etc. must hold a Level 1 Class Licence (WML-CL08) to survey GCN for scientific (including research) or educational purposes.

10.3.2 They should also be competent in habitat suitability assessment and the protocol for undertaking eDNA survey. They should be able to identify confidently all relevant amphibian species, their life stages and breeding habitats.

10.3.3 Survey teams will comprise of two surveyors for health and safety purposes.

10.4 Licensing requirements

10.4.1 In all cases survey within a specific geographical area will be coordinated by a holder of a Natural England licence to take and disturb great crested newt (for the purposes of science and conservation) with experience of co-ordinating large scale surveys.

10.4.2 Ideally, at least one of the two persons within any survey team will be a holder of a Natural England survey class licence[31] to take and disturb great crested newt. Use of accredited agents to lead pond survey visits (i.e. a team of two accredited agents working together) will only be acceptable where a curriculum vitae demonstrating their suitability for this role is submitted and approved by the overseeing consultants.

10.4.3 If survey of terrestrial habitat which would require use of pitfall trapping is required then an application will be submitted to Natural England.

10.4.4 Natural England require eDNA sampling being undertaken to accompany licence applications to be conducted by a holder of a survey licence or someone acting as an accredited agent to a licence holder.

[31] Natural England (2015), *Class licences for wildlife management - amphibians*. Available online at: https://www.gov.uk/government/collections/class-licences-for-wildlife-management#amphibians.

10.5 Screening for survey and defining the survey area

Desk based scoping exercise

10.5.1 A desk based scoping exercise to identify those water bodies requiring amphibian survey, and the likely appropriate survey effort will be undertaken and updated as required to take account of on-going changes to the design and extent of land required for the construction of the Proposed Scheme.

10.5.2 For the purpose of scoping all impacts on habitats are considered as likely to be permanent based on the prolonged construction period during which any 'temporary' working areas would be utilised.

10.5.3 All water bodies that may contain great crested newts are to be identified (including ponds, lakes, ditches, canals, streams and rivers) within a 500m radius of the assumed extent of habitat loss (i.e. the area within the land required for the Proposed Scheme). These are to be identified using GIS, OS Mastermap data and aerial photographs. GIS will then be used to calculate the distance of each water feature from the boundary of land required for the construction of the Proposed Scheme and the area of land falling within the extent of the land required for the construction of the Proposed Scheme falling within 100m, 250m and 500m of each water feature. This provides an indication of the maximum extent of terrestrial habitat losses that could occur in relation to each pond.

10.5.4 Each water feature identified through this process is then allocated to one of the following survey categories:

- no survey;
- Habitat Suitability Index (HSI)/walkover only;
- HSI + presence/absence either traditional methods or with/without eDNA; or
- HSI+ presence/absence either traditional methods or with/without eDNA + population size class assessment.

10.5.5 The approach taken to scoping seeks to ensure that survey effort is proportionate to the predicted level of impact as a consequence of the Proposed Scheme.

10.5.6 The 'HSI/Walkover survey only' category should in general only be used as a survey prescription for those features where habitat is considered likely to have marginal potential to support great crested newt (e.g. canals, ditches), but field data are required to confirm this assessment.

10.5.7 The eDNA screening method may be employed separately to screen ponds or in conjunction with presence/absence surveys. Where eDNA analysis confirms absence at a pond any remaining presence/absence surveys would not be completed.

10.5.8 For ponds located within the land required for the construction of the Proposed Scheme, or within a 250m buffer of the boundary of the land required, the basis for selecting water bodies requiring survey will be in line with current Natural England guidance provided within the most up-to-date version of the MS template available on the gov.uk website. However, for completeness all surveys should incorporate a Habitat Suitability Index (HSI) survey (see Table 2) where this methodology is applicable to the water body in question.

Table 2: Survey guidance for ponds within the land required for the construction of the Proposed Scheme or within 250m of the boundary of the land required

Scenario	Presence/ Absence	Population Size Class Assessment[32]	HSI
Pond lost or damaged as a consequence of development	✓	✓	✓
Pond not lost or damaged but within a 50m radius of the land required for the construction of the Proposed Scheme (land required) and terrestrial habitat lost	✓	✓	✓
Pond not lost or damaged but within 50- 100m radius of land required and terrestrial habitat losses of ≤0.2ha	✓		✓
Pond not lost or damaged but within 50- 100m radius of land required and terrestrial habitat loss of >0.2ha of terrestrial habitat	✓	✓	✓
Pond not lost or damaged but within 100-250m radius of land required and terrestrial habitat loss of ≤ 0.5ha	✓		✓
Pond not lost or damaged but within 100-250m radius of land required and losses of >0.5ha	✓	✓	✓

10.5.9 Source: Based on survey guidance table provided within Survey Data (1) tab of spreadsheet *Form WML-A14-2 (Version December 2015*).

10.5.10 For the vast majority of the alignment the route passes through arable and pasture fields that represent sub-optimal habitat for great crested newt. In general, therefore it is considered that newt habitat losses associated with ponds more than 250m from the land required for the construction of the Proposed Scheme are unlikely to be significant.

10.5.11 For the purposes of the initial scoping exercise, survey of those water bodies occurring more than 250m from the boundary of the land required for the construction of the Proposed Scheme has only been proposed where:

[32] Survey will only progress to Population Size Class Assessment if presence of great crested newt is identified during presence/absence survey.

- the terrestrial habitat around those ponds appear to be of poor value for great crested newts, and areas of more suitable terrestrial habitat are present within the Proposed Scheme; or
- the Proposed Scheme is considered to have the potential to fragment connectivity between ponds, such that there is a potential risk of fragmentation of metapopulations[33] through loss of terrestrial habitat; or
- a pond is considered to be part of a cluster of linked ponds and so may form part of the habitat used by a great crested newt metapopulation.

10.5.12 Appendix A details the framework utilised for determining the scope of great crested newt survey in these circumstances. Table 3 details the criteria used to define potential value of terrestrial habitat located more than 250m from the pond and the scale of barriers to movement relevant to each category.

Table 3: Defining potential value of terrestrial habitats located more than 250m from pond

Potential value of distant terrestrial habitats within the vicinity of the land required for the construction of the Proposed Scheme	Relationship to other suitable habitat
Low/Negligible	Habitats within land required for the construction of the Proposed Scheme of low or negligible suitability for great crested newt foraging and shelter (e.g. bare ground, improved grassland, arable fields, hard standing or buildings); and/or There is poor or no connectivity of suitable habitat with the land required (e.g. presence of a major barrier to movement such as an A road or motorway, or an extensive area of hard-standing and buildings); and/or Where unaffected areas of immediate and intermediate terrestrial habitat offering good connectivity with the water body and good opportunities for foraging and shelter (e.g. rough grassland, scrub, woodland, brown field habitats) are widely available closer to the pond in question such that it is considered unlikely newts would utilise distant habitat in anything other than very low numbers.
Medium	Where areas of immediate and intermediate terrestrial habitat offering at least some connectivity and good opportunities for foraging and shelter (e.g. rough grassland, scrub, woodland, brown field habitats) are available but are sufficiently limited in area (or patchy in distribution) that it is considered possible newts may also utilise distant habitat in low to medium numbers; or Where habitats within the land required and unaffected immediate or intermediate terrestrial habitat associated with the pond in question contain limited features suitable for great crested newt foraging and shelter (e.g. bare ground, improved grassland, arable fields, hard standing or buildings).
High	Habitats within land required considered to offer good connectivity of habitat and in general better opportunities for foraging and shelter (e.g. rough

[33] A metapopulation is a group of spatially separated populations of the same species which interact at some level.

Potential value of distant terrestrial habitats within the vicinity of the land required for the construction of the Proposed Scheme	Relationship to other suitable habitat
	grassland, scrub, woodland, brown field habitats) than those located closer to the pond in question. It is therefore considered likely these habitats would be utilised for foraging/shelter; or Availability of immediate and intermediate habitat suitable for foraging and shelter is considered sufficiently limited that alone it would not be sufficient to support any population associated with the pond in question.

10.5.13 In all cases the outputs of the flowchart provided as Appendix A should be reviewed by an ecological consultant alongside aerial photography and OS mapping and taken into consideration alongside a review of the spatial layout of suitable habitat (and the potential for fragmentation effects) and the presence of barriers to dispersal.

10.5.14 Table 4 details the basis for gauging the scale of likely impact of barriers to movement. However, in all cases a final judgement on the importance of the barrier should be taken in light of the wider geographical context and its distance from the breeding pond. For example, the presence of a B road in close proximity to a breeding pond would be unlikely to represent an absolute barrier to movement. However, it may be more significant when also located further from the breeding pond, or when habitat located on the far side of the barrier is of low or negligible value to newts.

10.5.15 Following consideration of all the above each water body within the confines of the scoping should be allocated to one of the survey prescription categories identified in paragraph 10.5.4.

Table 4: Guide to scale of potential barriers to amphibian movement

Scale of barrier to movement	Examples
Major	Motorway, dual carriageway, A Road, river or extensive areas of hard standing or intervening buildings (e.g. housing or industrial estate)
Moderate	B Road, major railway, major stream, moderate expanses of hard standing (e.g. small complexes of buildings or large car park)
Minor	Local road/track, minor railway, canal, minor stream or single buildings and small areas of hard standing

10.5.16 As for those water bodies within 250m the 'HSI/Walkover survey only' category should in general only be used for those features where habitat is considered likely to have marginal potential to support great crested newt (e.g. canals, ditches), but field data are required to confirm this assessment.

Ongoing field scoping and survey

10.5.17 Outcomes of the desk based scoping exercise should be used as the basis for requesting land owner access and survey planning. Where necessary when access is obtained the survey prescription should be reviewed. Where deviations in the scoping and survey approach are made, full justifications should be agreed with HS2 Ltd and documented.

10.5.18 Any additional water bodies identified during the course of other surveys (e.g. those identified during Phase 1 habitat survey) should be given an appropriate survey allocation following an HSI/walkover survey.

10.5.19 For all water bodies where 'HSI/Walkover survey' is prescribed an HSI assessment should be conducted (where appropriate) and a record made of the outcome of the survey (i.e. level of further survey prescribed or the rationale for scoping out). Where an HSI score of less than 0.5 (i.e. rating of 'poor') is achieved and inspection of the water body by an ecologist suggests that it is unlikely to support great crested newt, the water body may be scoped out.

10.5.20 In addition, throughout the course of field surveys consideration should be given to the need to increase the level of survey effort at those ponds initially only subject to presence/absence survey, due to changes in design or potential impact. Additional survey effort should be specified where this is considered necessary to provide a robust baseline for the assessment of potential significant effects.

10.6 Survey methods

Presence/absence (eDNA) survey

10.6.1 Surveys should be undertaken in accordance with Natural England's standing advice. This involves taking a series of water samples from each accessible water body scoped in for survey and sending the samples for laboratory analysis to test for great crested newt through the presence of eDNA. Reference should also be made to the Herpetofauna Workers Manual[34].

10.6.2 The methodology should only be considered to provide a reliable indication of likely absence in ponds or other discrete water bodies with no discernible flow of water. It is considered acceptable to use eDNA survey as a potential means of confirming presence of great crested newt in other water bodies such as canals or ditches. However, such results are not considered to provide a reliable negative survey result and therefore should not be relied upon to establish likely absence.

[34] Gent T and Gibson S (2003), *Herpetofauna Workers Manual*. JNCC, Peterborough.

10.6.3 At each water body subject to sample, the percentage of the pond margin accessible for survey should be recorded.

10.6.4 In all cases where eDNA survey is used, a Habitat Suitability Index assessment should also be undertaken using the methodology set out below.

10.6.5 Where eDNA analysis confirms the presence of great crested newt further survey is likely to be required in the same or subsequent years to provide an estimate of the population size class using the pond and provide suitable quantitative information to inform any subsequent application for a European Protected Species Mitigation Licence.

Presence/absence survey

10.6.6 During each survey visit until presence is confirmed at least three survey methods are to be employed. This should consist of the following:

- torchlight survey;
- bottle trapping; and
- egg searching.

10.6.7 In some cases, conditions at the pond or physical constraints to access (e.g. presence of dense scrub adjoining part of the ponds, or unstable margins) may mean that it is not possible or appropriate to utilise these preferred methods. In these cases, the unsuitable method should be substituted for an alternative method according to the following:

- netting should be utilised as the first alternative survey methodology; and
- refuge search should only be utilised where two or more other survey methodologies are inappropriate.

10.6.8 In each case where a deviation from the standard three survey methodologies is required, the survey notes are to include a justification for this deviation.

10.6.9 As soon as presence of great crested newt eggs is confirmed, egg searching will cease.

Population size class assessment

10.6.10 All survey visits are to utilise torchlight survey and bottle trapping unless these methods are not feasible. As soon as presence of great crested newt eggs is confirmed, egg searching will cease.

10.6.11 Where one of the three survey methods identified above is considered inappropriate the following guidance should be followed:

- if the peak recorded great crested newt count by a single survey method is fewer than 10 individuals, netting or, if this is not possible, refuge search should be used; but
- if a peak count of 10 or more great crested newts have previously been recorded using a single survey method, then use of alternative survey methodologies is not required.

Terrestrial habitat survey

10.6.12 In a small number of locations where access to a pond is not possible, it may be necessary to deviate from the standard methodology for presence/absence survey and conduct terrestrial habitat survey utilising pitfall traps on adjacent land to determine presence/absence.

10.6.13 In all such cases recommendations for terrestrial habitat survey of this type should be brought to the attention of Natural England immediately, along with recommendations for the proposed terrestrial habitat survey. The default position will be terrestrial presence/absence survey in accordance with Great Crested Newt Mitigation Guidelines (English Nature, 2001).

Late season amphibian survey

10.6.14 Where pond based presence/absence surveys are not completed during the available mid-March to mid-June survey window, late season amphibian survey (i.e. survey between mid-June and end of September) should be utilised where possible in order to gain an early indication of where great crested newts are present.

10.6.15 The methodology for late season amphibian survey is provided in Appendix B of this document.

10.6.16 Late season survey will only be used to confirm presence, and will not be utilised to assume absence. All ponds subject to late survey will also be subject to full survey during the mid-March to mid-June period.

10.7 Field survey techniques

10.7.1 Field survey techniques to be utilised are based on those provided within Great Crested Newt Mitigation Guidelines (English Nature, 2001), with additional guidance provided in order to ensure consistency.

eDNA survey

10.7.2 The eDNA survey method is set out in Biggs et al., 2014 (see 10.1 above). The approach set out below explains what the survey method is. It must be followed rigorously, as the results are otherwise unreliable.

10.7.3 A total of 20 water samples are to be taken from the pond margin without entering the water in order to prevent the potential for disturbance of sediment. The locations of sub-samples are to be spaced evenly around the accessible sections of the pond margin.

10.7.4 The samples should be targeted to ensure they include both areas with vegetation and open water if possible.

10.7.5 On arrival at a pond to be surveyed, surveyors should clean their hands with alcohol based cleaner and put on sterile gloves. Prior to samples being taken the pond water column is to be mixed without disturbing the sediment on the bed of the pond. Shallow water less than 10cm deep is not to be sampled. Each sample taken should be approximately 30ml.

10.7.6 All 20 samples should be combined into a 'Whirl-Pak' bag supplied by the laboratory and then shaken for 10 seconds to mix any DNA present across the whole sample.

10.7.7 After combining and shaking the samples, surveyors should discard their first pair of gloves and put on a new pair. The sample bag should then be split into six sterile conical sample tubes with 15ml of sample and 35ml of ethanol preservative. DNA will constantly sink to the bottom of the samples, so prior to each 15ml sample being taken the water in the 'Whirl-Pak' bag should be stirred. Each tube should also be shaken to mix the sample and preservative to prevent the eDNA decaying.

10.7.8 Any remaining water in the sample bag should be returned to the pond without the surveyor entering the water. All used equipment except the six sample tubes is to be discarded.

10.7.9 Sample tubes should then be returned as quickly as possible to a laboratory meeting the protocols for analysis set out in Biggs et al, 2014. Any samples that are stored prior to analysis will be refrigerated at 2-4^{0}C and should be stored for no more than one month. Samples are not to be frozen as storage bottles may then become damaged and leak.

10.7.10 Natural England now require samples to be tested at a laboratory that is participating in a proficiency testing scheme if the results are to be used for a licence application.

Torchlight survey

- all torchlight survey should utilise torches of at least 1 million candle power;
- torchlight survey should not commence until at least 1 hour after published local sunset time;
- where areas of the pond are omitted (due to restricted accessibility or health and safety constraints) an estimate of the percentage of the pond margin omitted and a justification for this is to be included within the notes section of the recording form;
- during each survey visit the turbidity and vegetation cover of the water body is be scored against the five point scales advocated by Natural England;
- where a turbidity or vegetation cover score of 4 is allocated, torchlight survey is still to be conducted but due to potential unreliability it should be complemented by use of an additional survey method (e.g. netting); and
- where a turbidity or vegetation cover score of 5 is allocated, torchlight survey is to be replaced by an appropriate alternative method (e.g. netting).

Egg searching

- egg searching is to be halted when searches confirm presence of great crested newt eggs, and from this point forward not be repeated during subsequent visits; and

- the use of 'egg strips' should only be considered where conventional egg searching is not appropriate and other constraints mean it is not possible to complete survey using three of the remaining available conventional survey methods (i.e. bottle trapping, torching, netting, refuge survey).

Bottle trapping

- all bottle traps used are to be created from clear plastic 2 litre round bottles and be secured utilising a bamboo cane or similar;
- where utilised, bottle traps are to be positioned at a frequency of one every 2m in areas of suitable habitat; for large water bodies where this is not practical, areas of trapping should focus on targeted survey of sections of the margin which support the most suitable habitat;
- where areas of the pond are omitted (due to restricted accessibility or health and safety constraints), an estimate of the percentage of the pond margin omitted and a justification for this is to be included within the notes section of the recording form;
- bottle trapping is only to be utilised on nights where overnight temperature is forecast to be 5°C or above;
- all bottle traps are to be set to include an air bubble; and
- bottle trapping should seek to avoid capture of water shrews; where they are known to occur or are identified during survey, bottle trapping should be replaced by an alternative survey method.

Netting

- all netting is to be conducted at night; as netting causes widespread disturbance of the pond, where used in combination with torchlight survey it should only be conducted following completion of torching; and
- nets utilised should have a mesh size of 2-4mm.

Refuge search

- where utilised as a pond survey methodology refuge search will be conducted during each of the proposed four/six survey visits;
- survey should incorporate checks of both natural refuges (such as logs, bark, rocks, debris) and where possible artificial refugia placed around the margins of the pond; and
- where it is clear that refuge search will be utilised as a survey methodology for subsequent visits, carpet tiles should be placed face down every 2m around the pond margin and the refuges allowed to settle 7 days before the next survey visit.

Habitat Suitability Index

10.7.11 A Habitat Suitability Index (HSI) is to be calculated for all ponds within the land required for the construction of the Proposed Scheme, or within a 250m buffer of its boundary that are identified as requiring presence/absence or population size class assessment survey, according to the criteria set out in Table 2, as well as any other ponds that are subject to full survey.

10.7.12 All surveyors are to use the simplified HSI methodology described in ARG UK Advice Note 5: Great Crested Newt Habitat Suitability Index (2010)[35].

10.7.13 Where possible HSI scores for the ten component indices are to be calculated from data collected during a survey visit during the period mid-April to mid-May. During subsequent surveys notes are to be made of factors/events that may have resulted in a significant change to the HSI score previously calculated.

10.7.14 Where a suitability index cannot be allotted for any of the ten component indices then a comment should be recorded to explain this. In addition, a comment should be recorded where the surveyor considers that the atypical nature of a water body may result in an unreliable HSI score.

Dealing with non-native amphibians

10.7.15 If non-native amphibian species occurring on Schedule 9 Part 1 of the Wildlife and Countryside Act 1981 (as amended) are captured during the course of the survey (e.g. within bottle traps or nets) they will not be released back into the wild. They will need to be humanely euthanized using an accepted method unless the surveyors are aware of opportunities for these animals to be taken into captivity.

10.8 Survey programme and effort

eDNA survey

10.8.1 eDNA surveys consist of a single visit to a pond, ideally during daylight hours, to collect water samples.

10.8.2 To reliably confirm the presence or likely absence of great crested newt, sample collection should be undertaken between mid-April and the end of June.

[35] Amphibian and Reptile Groups of the United Kingdom (2010), *ARG UK Advice Note 5: Great Crested Newt Habitat Sustainability Index.* Amphibian and Reptile Groups of the United Kingdom.

Presence/absence survey

10.8.3 Presence/absence surveys are to comprise four visits in suitable weather conditions as defined in Great Crested Newt Mitigation Guidelines (English Nature, 2001).

10.8.4 Visits are to be conducted during the period mid-March to mid-June, with at least two visits during the period mid-April to mid-May.

10.8.5 Visits should ideally be well spaced (no more than one per week and no more than four weeks apart). Survey visits to the same pond on consecutive nights should be avoided. In the event that the required survey effort is not completed then the use of non-standard methodologies which may provide early warning to the presence of great crested newts will be considered (see Appendix B). These methods cannot be utilised to determine absence, and in all cases water bodies subject to these methods will be subject to full survey utilising standard methods.

10.8.6 Where presence/absence survey is not completed during the first year of survey then the survey will be repeated in full during the following survey season (e.g. if only two visits completed during the first year then a further four visits should be conducted during the second year of survey).

Population size class assessment

10.8.7 Population size class assessment is to comprise six pond visits in suitable weather conditions (English Nature, 2001). These are to be conducted between mid-March to mid-June, with at least three of these visits during the period mid-April to mid-May.

10.8.8 Visits should ideally be well spaced (no more than one per week and no more than four weeks apart). Survey visits to the same pond on consecutive nights should be avoided.

10.8.9 In the event that the required survey effort is not completed during the first year of survey then the survey should be repeated in full during the following survey season (e.g. if only two visits completed during the first year then a full six visits should be conducted during the second year of survey).

Habitat Suitability Index

10.8.10 HSI scores for the ten component indices are to be calculated from data collected during a survey visit. Where constraints allow this should be conducted during the period mid-April to mid-May.

11 Reptiles

11.1 Introduction and guidelines

11.1.1 It is anticipated that a range of habitats within the land required for the construction of the Proposed Scheme will represent suitable habitat to support widespread reptile species, namely adder (Vipera berus), slow worm (Anguis fragilis), grass snake (Natrix natrix) and common lizard (Zootoca vivipara). The route is located outside of areas known to support sand lizard (Lacerta agilis) and smooth snake (Coronella austriaca). As a consequence, it is unlikely that survey for these species will be required.

11.1.2 Common reptiles are known to be absent from some large areas of intensively farmed land and in larger urban environments. Where absence from such areas can be confirmed through consultation with local experts, it may be possible to scope out such areas from survey.

11.1.3 Reptile survey in support of the Proposed Scheme will be conducted according to a bespoke methodology which draws heavily upon standard guidance documents[36,37,38].

11.2 Qualifications and experience

11.2.1 All surveyors involved in screening and scoping for reptiles should be competent in the following:

- field identification of all widespread reptile species and field signs (e.g. sloughs, burrows and eggs);
- assessing the potential suitability of on-site habitats for widespread reptile species;
- determining appropriate spatial scope for survey; and
- identifying appropriate survey techniques to achieve a robust survey in a variety of habitat types.

11.3 Licensing requirements

11.3.1 Survey is only anticipated to involve widespread reptile species; as such no survey licence is required.

[36] Froglife (1999), *Reptile survey; an introduction to planning, conducting and interpreting surveys for snake and lizard conservation.* Froglife Advice Sheet 10. Froglife, Halesworth.

[37] Gent T and Gibson S (2003), *Herpetofauna Workers Manual*. JNCC, Peterborough.

[38] Natural England (2011), *Natural England Technical Information Note TIN102: Reptile Mitigation Guidelines,* Natural England, Peterborough. (Note this guidance was published and subsequently withdrawn in September 2011).

11.4 Screening for survey and defining the survey area

11.4.1 Consultants should review preliminary work, alongside desk study data and the results of Phase 1 habitat survey to identify any additional areas of potentially suitable habitat within the land required for the construction of the Proposed Scheme and a surrounding 100m buffer.

11.4.2 For all such areas identified as containing habitat potentially suitable to support reptiles, a walkover survey should be conducted by a competent ecologist in order to appraise the suitability of the habitats present on the ground. The habitat assessment should be based on consideration of the following characters:

- location in relation to species range;
- vegetation structure;
- insolation (sun exposure);
- aspect;
- topography;
- surface geology;
- connectivity to nearby good quality habitat;
- prey abundance;
- refuge opportunity;
- hibernation habitat potential;
- disturbance; and
- egg-laying site potential (grass snake only).

11.4.3 For each habitat area the output of the habitat assessment should be a grading of each habitat area as having either 'poor', 'good' or 'exceptional' potential to support widespread reptiles, based on reasoned consideration of the above factors. Examples are provided in Table 5.

Table 5: Grading of reptile habitat suitability

Habitat grading	Definition
Poor	Habitat which is unfavourable for reptiles based on the majority of the habitat assessment characters listed above or is limited in size and highly isolated from other areas of suitable habitat.
Good	Habitat which is favourable or sub-optimal for many of the habitat assessment characters listed above; or is sub-optimal for some of the characters and has good connectivity with areas of more suitable habitat.
Exceptional	Habitat which is favourable for reptiles based on the majority of habitat assessment characters listed above.

11.4.4 The grading of each habitat area should note for which species the habitat area is potentially suitable.

11.4.5 Where habitat areas identified for walkover survey are found to contain distinct areas of habitat that do not contribute to the overall value of the habitat parcel for reptiles, the habitat area should be divided. A unique reference code and habitat grading should then be allocated to each habitat area. For example, an area of improved grassland within a block of rough grassland and scrub would be given its own unique reference code and graded as being of 'poor' value based principally on the habitat structure.

11.4.6 All habitat areas falling within the identified survey extent identified as having 'good' or 'exceptional' potential to support reptiles and no significant barriers preventing dispersal to land require for the construction of the Proposed Scheme will be selected for further presence/absence survey utilising artificial refugia.

11.5 Survey method

11.5.1 Where health and safety and access constraints allow, all habitat areas identified as having 'good' or 'exceptional' potential to support reptiles using the table above will be subject to survey utilising artificial refugia.

11.5.2 In each habitat area a combination of corrugated iron and roofing felt refugia all measuring a minimum of 0.5m x 0.5m are to be placed out in areas identified as suitable habitat. At sites where the habitat assessment has identified potential for grass snake to occur surveyors should deploy an appropriate number (based on extent of suitable habitat) of larger refugia, to increase the likelihood of detecting this species.

11.5.3 In non-linear habitats refugia should be placed at a density of at least 100/ha or a minimum 30 mats in very small sites. In linear habitats of less than 10m in width (e.g. hedgerows and road verges) refugia should be placed at a frequency of at least one every 10m of suitable habitat.

11.5.4 The default should be a 50:50 ratio of corrugated steel/iron to roofing felt. Where varying from this standard a justification should be provided, based on the habitat type and target species concerned.

11.5.5 All refugia should be number marked using spray paint and their location accurately recorded to an accuracy of <5m where terrain/vegetation allows, to allow later translation to GIS. It is recommended that locations are recorded using a GPS device.

11.5.6 Once placed out artificial refugia will be left to settle for 14 days prior to conducting the first check. Each site containing refugia will then be checked for reptiles on the required number of occasions (see Section 11.6). Binoculars should be used to check for reptiles between and on top of refugia, as well as careful checks by lifting each refugium.

11.5.7 Each refugia check should be conducted during the following conditions:

- time: conducted between 07:00 and 18:00;
- air temperature: 10°C - 20°C;
- wind: Still to moderate (equivalent to Beaufort 4; 13 - 17mph); and

- rain: No or light rain only at time of survey. Surveys between periods of heavy rain (when all other conditions are suitable) are also acceptable.

11.5.8 During each check the surveyor should record details of all reptiles encountered during the survey, including refugia number, species, number, life stage (adult, sub- adult, juvenile) and when possible, sex.

11.5.9 If non-native species listed on Schedule 9 are found during the survey, then details will be recorded as described above. As no handling of reptiles is anticipated as part of the survey all non-native species will be left in-situ. Where necessary provisions for their removal will be included within the ES and any subsequent mitigation statements.

11.5.10 All records of reptiles should be provided with GPS-derived grid coordinates. Where topography and vegetation structure may have reduced the accuracy of records below an accuracy of <5m, this information should be noted.

11.5.11 Where areas of suitable reptile habitat are located within the boundaries of the existing operational rail or road estate it is anticipated that there may be both health and safety and access issues that will prevent refugia survey of all those areas of habitat identified as potentially suitable for reptiles. In these cases, the consultants undertaking surveys will be expected to liaise with the overseeing consultant in order to determine a suitable survey approach for these areas. It is anticipated that this will involve consideration of the following potential approaches:

- sampling of areas of similar adjacent habitat;
- visual search only; and
- risk assessment based on habitat suitability.

11.6 Survey programme and effort

Presence/absence survey

11.6.1 At all locations selected for refugia survey initially, seven visits (during suitable weather conditions) should be conducted to determine presence/absence.

11.6.2 Each visit should adhere to the weather requirements detailed above and should be conducted during the period April to September.

11.6.3 Where access allows surveys should be programmed to maximise the number of visits conducted during April, May, June and September, when weather conditions are likely to be more favourable for survey. However, visits during July and August are not precluded assuming they are conducted according to the weather requirements detailed above.

11.6.4 There should be at least 30 days between the first and last survey visits and there must be a minimum of two days between each visit.

11.6.5 A robust survey to determine likely absence should include at least four visits conducted during the 'optimum' survey months of April, May, June or September. As a consequence, at sites where surveys commence during July or August if no reptiles are found during the first three visits, the remainder of visits should be delayed and conducted during September.

Estimating population size class

11.6.6 Where presence/absence survey confirms presence of one or more reptile species and all survey visits have been conducted during the 'optimum' survey months of April, May, June or September (under suitable conditions) then (unless the surveyor considers it necessary) no further visits will be required.

11.6.7 To give a robust estimate of population size where any survey visits have been conducted during the sub-optimal months of July or August, additional visits will be required until at least seven visits (under suitable conditions) have been conducted during optimum months.

11.6.8 Where initial survey results suggest that a site has the potential to support a 'high' reptile population then the consultants undertaking the survey should consider the requirement for further visits to provide a robust population size class estimate.

11.6.9 Population size class should be assessed utilising the peak adult count for each species across all visits. These figures should be divided by the survey area in ha to give an indication of density identified within the survey, then compared with the criteria outlined in 'Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards' (HGBI, 1998)[39]. A summary is provided in Table 6.

Table 6: Estimating population size[40]

Species	Population size class	Density recorded
Slow worm	High	more than 100/ha
	Medium	50-100/ha
	Low	less than 50/ha
Common lizard	High	more than 80/ha
	Medium	20-80/ha
	Low	less than 20/ha
Grass snake	High	more than 4/ha
	Medium	2-4/ha
	Low	less than 2/ha
Adder	High	more than 4/ha
	Medium	2-4/ha
	Low	less than 2/ha

[39] Herpetofauna Groups of Great Britain and Ireland (1998), *Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards*. HGBI, Halesworth.

[40] Derived from HGBI (1998) Evaluating local mitigation/translocation programmes: Maintaining best practice and lawful standards.

Surveys split between seasons

11.6.10 Where surveys are commenced but not completed in one year, they can be 'topped up' with visits in the subsequent year, assuming that the resulting data set meets the relevant conditions for timing, survey conditions and number of visits as set out above.

12 Breeding birds

12.1 Introduction and guidelines

12.1.1 The purpose of breeding bird surveys within the context of ES is to establish baseline data on the species, numbers and distribution of birds within and adjacent to the land required for the construction of the Proposed Scheme so that potential significant impacts of the scheme can be assessed.

12.1.2 A review of methods available for survey of breeding birds can be found in Bibby, et al (2000)[41].The principal method employed for the ES of the Proposed Scheme will be a variation of the Common Bird Census (CBC) methodology[42], involving five visits during the breeding season. Where initial survey visits are conducted during the first year in order to provide an early understanding of bird use of the route of the Proposed Scheme, the full five visits should be repeated during the following year in order to provide reliable data for use in territory analysis. Where appropriate, further specific surveys will be undertaken for protected and/or notable species (e.g. barn owl, hobby, nightjar, black redstart).

12.2 Qualifications and experience

12.2.1 Surveyors should be able: to identify birds confidently from visual observation as well as songs/calls; to identify specific bird habitats that could support nesting birds listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended); to identify bird behaviours, including territorial displays and nesting behaviour; to use with confidence common survey techniques including territory mapping, point counts and transect surveys; and to interpret bird survey data.

12.3 Licensing requirements

12.3.1 A Natural England licence is required where surveys are likely to disturb Schedule 1 species, including nesting barn owls. In the vast majority of cases survey according to the Common Bird Census (CBC) methodology is unlikely to constitute a legal offence. Where necessary, transect routes should be sensitively modified in order to limit disturbance. However, ultimately individual surveyors should for all proposed surveys judge where disturbance is likely to occur and provide appropriately licensed survey staff where necessary.

[41] Bibby, Colin J. (2000), *Bird census techniques*. Elsevier.

[42] Baillie, S.R. (2012), *BirdTrends 2011: trends in numbers and demography for UK breeding birds*, British Trust for Ornithology. Available online at: https://www.bto.org/about-birds/birdtrends/2011/methods/common-birds-census.

12.4 Screening for survey and defining the survey area

12.4.1 The locations extent of the CBC style survey (as described in Section 12.5) should be defined by the outcome of Stage 1 and Stage 2 below.

Stage 1 – Sites of known importance for breeding birds

12.4.2 Surveyors should initially undertake a review of existing information (designation details, desk study records of notable species, county bird reports) to identify sites of known importance for birds where there is considered to be the potential for adverse effects as a consequence of the Proposed Scheme. The necessary extent of this search area will vary based on the nature of the sites present and the proposed engineering design of the Proposed Scheme. However, as a minimum this search should encompass a 250m buffer either side of the land required for the construction of the Proposed Scheme.

12.4.3 Any such sites where there is considered to be the potential for adverse effects as a consequence of the Proposed Scheme will be included within the scope of the CBC style survey.

Stage 2 – Other areas identified as being of potential importance for breeding birds

12.4.4 Surveyors should undertake a review of the following information sources to identify locations of potential importance for breeding birds (i.e. areas which are considered to have potential to support notable species such as those listed on Annex 1 of the Birds Directive, Schedule 1 of the Wildlife and Countryside Act, or red or amber listed species on the Birds of Conservation Concern list[43]; or which may support notable assemblages of common birds) within the land required for the construction of the Proposed Scheme and a 250m buffer either side of it that are potentially subject to adverse effects:

- aerial photography and Ordnance Survey mapping;
- Phase 1 habitat survey results;
- feedback from Early Ecology Survey bird surveys; and
- discussion with local consultees.

12.4.5 Any such sites will be included in the scope of the CBC style survey.

[43] Hayhow DB, Bond AL, Douse A, Eaton MA, Frost T, Grice PV, Hall C, Harris SJ, Havery S, Hearn RD, Noble DG, Oppel S, Williams J, Win I and Wotton S (2017), *The state of the UK's birds 2016*. The RSPB, BTO, WWT, DAERA, JNCC, NE, NRW and SNH, Sandy, Bedfordshire.

Stage 3 – Sampling of other habitats (i.e. those not covered by Stage 1 and Stage 2)

12.4.6 Following completion of Stages 1 and 2 a survey strategy should be established to ensure that survey includes a sample of all other habitats within the land required for the construction of the Proposed Scheme and a 250m buffer either side of it. This is intended to provide an indication of the birds using these habitats and should give preference to areas within the land required for the construction of the Proposed Scheme. As a guide the sampling of other habitats that are not identified in Stage 1 and Stage 2 should seek to achieve a minimum of 20% coverage within each community area. It should be noted that this is in addition to the coverage required to satisfy Stage 1 and Stage 2. Coverage may be increased where appropriate. As a guide the sampling of other habitats that are not identified in Stage 1 and Stage 2 should seek to achieve a minimum of 20% coverage within each community area. It should be noted that this is in addition to the coverage required to satisfy Stage 1 and Stage 2. Coverage may be increased where appropriate.

Stage 4 – Further detailed survey for protected and/or notable species

12.4.7 Consultants undertaking survey should consider the requirement for additional survey work in order to assess potential impact on species listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) [44] and Annex 1 of the Birds Directive[45].

12.4.8 Consultants should undertake a desk based exercise to identify the likely extent of Schedule 1/Annex 1 species surveys required within the areas for which they are responsible. The results of the desk based exercise should initially consider records from within 5km and a desk based appraisal of suitable habitat availability within 1.5km to determine the scope of detailed field surveys required.

12.5 Survey methods

Common Bird Census style survey

12.5.1 Surveys will comprise five visits between mid-March and the end of June with at least ten days between each visit. Where access allows these should be spread as evenly as possible throughout the survey season. Unless a site-specific deviation is agreed then where access allows the full five visits should be conducted even where some survey visits were achieved in the previous year.

[44] *Wildlife and Countryside Act (1981) Chapter 69.* Her Majesty's Stationery Office.

[45] *Directive 2009/147/EC of the European Parliament and of the Council on the conservation of wild birds (2009).* Official Journey of the European Union.

12.5.2 Survey visits will be undertaken on dry days with no more than moderate wind. Survey during dawn mist is acceptable but survey during dense fog should be avoided. Site visits should commence no later than one hour after sunrise. In order to avoid confusion and reduce survey bias in areas with high densities of birds the survey should be commenced towards the end of this window. In addition, the starting position should be varied between visits in order to reduce survey bias. In all cases survey should ideally be completed by 11am (12 noon at the latest).

12.5.3 Due to the scale of the survey proposed it will not be practical to approach all areas within 50m. As a consequence, in large expanses of open grassland or arable fields the boundaries will be walked and all birds within the field recorded. In other habitat where access and views allow, efforts will be made to record all bird activity within 50m of the survey route.

12.5.4 In all cases all birds seen or heard will be identified and recorded on a suitable scale map of the site to allow the information to be clearly recorded using standard British Trust for Ornithology (BTO) species and activity codes.

12.5.5 Large wetland areas can be covered by the CBC style survey as proposed above but will be a combination of recording the activity of individual birds and counts of birds on the water from the lake edge.

Species specific surveys

12.5.6 Species specific surveys should be conducted as appropriate, and where considered to be required based on the results of scoping and results from Phase 1 habitat survey and initial breeding bird surveys, should include both the land required for the construction of the Proposed Scheme and a surrounding 250m buffer. As a minimum this should include consideration of potential nesting locations for Schedule 1 species such as barn owl, red kite (*Milvus milvus*), hobby and peregrine (*Falco peregrinus*).

12.5.7 Survey for Schedule 1 species should follow established best practice survey methodologies as follows:

- barn owl – Shawyer (2011)[46]; and
- red kite/hobby/peregrine/black redstart/nightjar/kingfisher[47].

12.5.8 Where crepuscular or nocturnal species such as nightjar and woodcock are suspected then evening survey visits (in addition to those forming part of the CBC survey) should be undertaken. At each appropriate site at least two evening visits including the hour after sunset should be conducted.

[46] Shawyer, C.R. (2011), *Barn Owl Tyto alba: Survey Methodology and Techniques for use in Ecological Assessment.* Developing Best Practice in Survey and Reporting. IEEM, Winchester.

[47] Gilbert, G., Gibbons, D.W. and Evens, J. (1998), *Bird Monitoring Methods: A Manual of Techniques for Key UK Species*, Royal Society for the Protection of Birds.

13 Wintering and passage birds

13.1 Introduction and guidelines

13.1.1 Survey methods are to be appropriate for lowland rural habitats including farmland and wetlands. These should be based on the methods in Gilbert et al (1998)[48] and the Wetland Bird Survey (WeBs) methodology[49].

13.2 Qualifications and experience

13.2.1 Surveyors should be able to identify birds confidently from calls as well as visual observation and should be competent in the survey methods identified below.

13.3 Licensing requirements

13.3.1 There are no licensing requirements for wintering bird survey.

13.4 Screening for survey and defining the survey area

13.4.1 Consultants undertaking surveys should aim to screen and consider discounting areas from survey where it is likely that the habitats support only low numbers of common birds whose conservation status would not be significantly affected by the Proposed Scheme. It is anticipated that wintering bird survey will focus on survey of water bodies with sampling of woodland and farmland habitats.

13.4.2 The decision on which areas to include in the scope of wintering bird surveys should be based on:

- records of notable species from desk study (bird data from the local Biological Records Centre and the County Bird Report);
- the presence of good quality habitat, as identified during the Phase 1 habitat survey; and
- discussions with local consultees.

13.4.3 All areas identified based on the above criteria should be included within the wintering bird survey. In addition, within each 10km section of the route the survey should include a representative sample of approximately 10% of all farmland and woodland habitats located within the land required for the construction of the Proposed Scheme and within a 100m

[48] Gilbert, G., Gibbons, D.W. and Evans, J. (1998), *Bird Monitoring Methods: A Manual of Techniques for Key UK Species.* Royal Society for the Protection of Birds.

[49] Pollit, M.S., Hall, C., Holloway, S.J., Hearn, R.D., Marshall, P.E., Robinson, J.A., Musgrove, A., Robinson, J., and Cranswick, P.A. (2003), *The Wetland Bird Survey 2000-2001: Wildfowl & Wader Counts*. Slimbridge.

buffer of the land required. Where access is freely available the areas selected for survey should cover a range of different habitat types and focus on locations within or directly adjacent to the land required.

13.4.4 Consultants undertaking surveys should use professional judgement to determine those locations where more intensive survey (i.e. above the level described above) is required.

13.5 Survey method

13.5.1 Wintering and passage bird survey will focus on wetland sites and will use the WeBs methodology.

13.5.2 In each case the survey is to be undertaken at all wetland sites within the land required for the construction of the Proposed Scheme and within the 100m buffer of the land required. Survey will be conducted once per month through October to February, with additional visits during September and/or March where necessary to detect anticipated target species.

13.5.3 Outside wetland areas known to be of importance for wintering or passage birds, surveys within farmland, woodland and any other areas of suitable habitat identified by surveyors, will be based on a sampling approach. Outside wetland areas, surveys should aim to sample approximately 10% of the suitable habitat located within 100m of the land required for the construction of the Proposed Scheme for each 10km section. The length of the total survey route required to obtain this coverage will vary depending on the extent of views. Visible areas should be mapped by surveyors during the first survey visit to show the survey extent. Surveyors are to determine whether sampling density needs to increase locally to address habitat variety or complexity.

13.5.4 The route of the survey will be chosen to sample the range of suitable habitat types present. All visits are to be completed between one hour after sunrise and one hour before sunset.

13.5.5 On each of the survey visits the surveyor is to walk the survey area at a steady pace recording the location of all birds seen or heard on a plan using standard BTO species codes.

13.5.6 Vantage point survey should be conducted in wetland areas where construction of viaducts is proposed. Survey should comply with current Natural England guidance as outlined within TIN008 Assessing ornithological impacts associated with wind farm developments: surveying recommendations[50] and include at least 36 hours of survey at each vantage point location over the period September to mid-March inclusive.

[50] Natural England (2007), *Technical Information Note TIN008 Assessing ornithological impacts associated with wind farm developments: surveying recommendations.* First edition 15 October 2007. Available online at: www.naturalengland.org.uk

13.6 Survey programme and effort

13.6.1 The survey programme for wintering bird surveys is described above.

14 Bats

14.1 Introduction and guidelines

14.1.1 Proposed survey methodologies are largely based on the Bat Workers Manual[51], Bat Mitigation Guidelines[52] and Bat Surveys: Good Practice Guidelines 3rd Edition[53]. Reference has also been made to the survey methods recommended within Design Manual for Roads and Bridges Volume 10[54], and the DEFRA research report WC1060[55].

14.1.2 The following section details the scope of survey work and methodologies for these surveys. Determining the extent of survey will be an iterative process. Results of initial bat survey work are likely to identify the requirement for further surveys in some locations. Bat surveys focus on identifying and understanding how bats use the area within and around the Proposed Scheme for roosting, feeding and commuting.

14.1.3 A desk study is used to identify the species recorded and the presence of known roosts within the local area. Following this, visual inspection is used to identify features with potential to be used as bat roosts; this may then be supplemented by closer and more detailed inspection of some features with higher potential; and when inspection is not possible or the findings are not conclusive, dusk and dawn bat surveys can be undertaken to identify whether any bats are emerging or re-entering potential roost features.

14.1.4 Bat activity surveys are then used to identify movement and activity by bats around a site, including bat commuting routes and features that may be important in bat navigation/orientation.

14.1.5 Detailed bespoke methodologies for locations where the presence of bat species listed on Annex II of the EU Habitats Directive is suspected will be devised in liaison with Natural England and, where appropriate, with local bat groups and researchers working in the area.

14.1.6 Consultants undertaking surveys should ensure that all descriptions of roost types utilised during the project are in line with the terms and definitions provided in Collins (2016), as detailed in Table 8.

[51] Mitchell –Jones, A.J., and McLeish, A.P. (2004), *Bat Workers' Manual*. Peterborough: Joint Nature Conservancy Council.

[52] Mitchell-Jones, A.J. (2004), *Bat Mitigation Guidelines (IN136).* English Nature, Peterborough.

[53] Collins, J. (Ed) (2016), *Bat surveys for professional ecologists: good practice guidelines* (3rd Edition). Bat Conservation Trust, London.

[54] Highways Agency (2001), Design Manual for roads and Bridges – Volume 10, Section 4, Part 3. Nature Conservation Advise in relation to bats. Highways Agency, London.

[55] Department for Environment, Food and Rural Affairs (2015), *WC1060 Development of a cost-effective method for monitoring the effectiveness of mitigation for bats crossing linear transport infrastructure.*

14.2 Qualifications and experience

14.2.1 All bat survey work conducted in support of the Proposed Scheme will be conducted by suitably qualified and experienced persons. All work that is considered likely to result in disturbance of bats or their roosts will be conducted by holders of Natural England class licences[56] to 'take and disturb' bats for the purpose of science and conservation. Specific licencing details for particular types of survey are identified in Section 14.4 below.

14.2.2 Surveyors who are internally surveying spaces such as loft voids should have appropriate training (e.g. for working at height and in confined spaces). Surveyors undertaking tree climbing inspections must have the appropriate training and certification. Section 14.4 below identifies the specific requirements for different survey types.

14.2.3 It may be suitable for some activities (e.g. initial assessments) to be conducted by non-licensed but suitably experienced ecologists as long as no disturbance activities are undertaken such as use of endoscopes or torches lighting potential roost locations.

Initial bat roost potential assessments

14.2.4 Assessment of trees and buildings for roosting potential which does not result in disturbance may be conducted by all suitably qualified and experienced persons. All persons conducting such a survey should be experienced in field survey of roosting potential of trees and buildings, including a good knowledge of the following:

- the legislation and protection afforded to bats;
- bat life cycle;
- locating and identifying field signs of roosting bats (e.g. droppings, scratch marks and urine staining);
- using signs of bats found to locate likely roosting positions, likely genus of bat and type of roost;
- species-specific and seasonal requirements of roosting bats and the various natural features and manmade structures used for roosting;
- the range of survey methods that can be used to identify and study bats, and their strengths, weaknesses and limitations;
- describing construction of buildings and other structures, including the materials utilised and the form of features present (e.g. hipped roof, gable end, trussed rafters); and
- current relevant guidance for surveying bats.

[56] Natural England (2015), *Class licences for wildlife management - mammals*. Available online at: https://www.gov.uk/government/collections/class-licences-for-wildlife-management#mammals.

14.2.5 If non-licensed surveyors identify evidence of an active roost during initial assessments, then it will be necessary for them to cease surveying. The survey will subsequently be completed when a licensed surveyor is present.

Internal survey

14.2.6 Surveys of known roosts, or potential hibernation roosts, should be undertaken by ecologists with the appropriate Natural England licence.

14.2.7 Survey teams conducting internal inspection of buildings/structures between May and September (when bats are most likely to be present) should include at least one Natural England licensed bat worker.

Emergence/activity survey

14.2.8 It is recommended that each team of surveyors conducting emergence/return to roost or activity surveys at a discrete location (i.e. a single tree, group of trees, building or structure) should include at least one licensed bat worker to coordinate the survey. At complex or large sites, a higher proportion of licensed bat workers should be utilised.

14.2.9 All other surveyors assisting in the implementation of emergence/activity surveys should have a sound knowledge and understanding of the following:

- the legislation and protection afforded to bats;
- bat life cycle;
- feeding strategies used by difference bat species;
- the physiology and flight characteristics of UK bats;
- the range of survey methods that can be used to identify and study bats, and their strengths, weaknesses and limitations;
- species specific and seasonal requirements of roosting bats and the range of features utilised by each species;
- using a range of bat detectors to identify species and record behaviour; and
- current relevant guidance for surveying bats.

Further surveys

14.2.10 Any subsequent bespoke surveys for Annex II species will be overseen by licensed bat workers who are competent in surveying and assessing the impacts of development on, the species concerned. Licensed bat workers devising survey scope and methodologies on the project should have experience of undertaking ecological impact assessment in support of linear infrastructure projects and designing successful mitigation schemes.

14.3 Screening for survey and defining the survey area

14.3.1 Aerial photograph interpretation (and where available Phase 1 habitat mapping and desk study records) will be utilised to identify all buildings, trees and other features with potential to provide a place of shelter for bats within the land required for the construction of the Proposed Scheme and within a surrounding 100m buffer of the boundary of the land required.

14.3.2 In addition, consultants undertaking surveys should conduct a review of all habitats, buildings, trees and existing desk study records within a 500m buffer either side of the land required for the construction of the Proposed Scheme to identify any additional features where the following apply:

- there is the potential for significant effects on populations utilising these features; or
- information regarding bat use of the features/habitat in question will be important in determining a robust baseline that allows the significance of impacts within and in proximity to the Proposed Scheme to be accurately assessed.

14.3.3 An assessment of the need for survey of features more than 100m from the boundary of the land required for the construction of the Proposed Scheme should include consideration of the following:

- existing information on bat species, populations and roosts;
- protected sites, for example a Special Area of Conservation or Site of Special Scientific Interest designated for bats;
- the context of the site in its surroundings;
- extent and quality of habitat within and around the site including water features, hedges, woodland and/or veteran trees;
- presence of known roosts or suitable buildings and other structures for roosts; and
- types of roost and species present (Collins, 2016).

14.3.4 The scope of surveys will in the first instance be confined to habitats within a 100m buffer either side of the boundary of the land required for the construction of the Proposed Scheme and features of particular interest within a 500m buffer of the boundary of the land required that are identified by the consultants responsible for bat survey in the area concerned. As the extent of the land required for construction will alter with design changes it will be necessary to regularly review which features require survey. Surveys will not be required for trees that are within areas identified for habitat creation as any such trees will not be lost or damaged.

14.3.5 In urban sections the scope of survey will be limited to the land required for the construction of the Proposed Scheme (and the adjacent Network Rail estate where the Proposed Scheme will run adjacent to existing rail lines) and any significant features/areas of semi-natural

habitat adjoining the land required for the construction of the Proposed Scheme that are identified during aerial photograph interpretation. Within urban areas survey of retained residential housing adjoining the route should only be conducted where there is considered to be the potential for significant adverse effects.

14.4 Survey methods

14.4.1 The following methodologies are intended to provide robust baseline data on widespread UK bat species. If bat species listed on Annex II of the Habitats Directive[57]are found/ suspected to be present, additional survey work targeted at these species will be required to supplement the baseline.

Definition of potential to support roosting bats

14.4.2 Whilst undertaking preliminary survey work, the surveyor should assign value to each feature within each building/tree in accordance with the scale set out in Table 7. Where surveyors consider it appropriate, the potential rating of a particular feature may be upgraded based on professional judgement and/or prior knowledge of the site (e.g. an optimal feature on a tree located within sub-optimal surrounding habitat may normally be graded as moderate, but may be upgraded to high where the surveyor has prior knowledge of unusually high bat activity in its vicinity).

Table 7: Potential to support roosting bats (based on table in Hundt, 2012)

Potential to support roosting bats	Equivalent tree categories within Collins (2016)	Description
Confirmed	Known or confirmed roost	A feature/structure within which bats are seen to be present (either live bats, or bat carcasses) or heard 'chattering' will be classified as a confirmed roost. In addition, any feature/structure found to contain droppings during inspections will in the first instance be considered as a confirmed roost. N.B. In some cases, it may be appropriate to revise this assessment following further survey (e.g. for buildings containing low numbers or old droppings and showing no evidence of use during emergence surveys).
High	High	A feature/structure which, due to its size, depth, shape, orientation or other physical properties (such as ability to maintain a constant temperature, accessibility for bats) is considered to be ideal for use by bats in larger numbers and on a more regular basis and potentially for longer periods of time. Potential feeding remains, urine staining or scratch marks (in the absence of droppings) within or around the feature are likely to indicate presence of bat occupation and therefore suggest high potential that a roost is present. In the absence of such signs, assigning a feature high potential will also be informed by the surveyor's knowledge of bat ecology and preferred roost types (relative to the feature being assessed). The quality of the surrounding habitat for bats will also be considered. For example, a building

[57] Lesser horseshoe bat (*Rhinolophus hipposideros*), Greater horseshoe bat (*Rhinolophus ferrumnequinum*), Barbastelle (*Barbastella barbastellu* and Bechstein's bat (*Myotis bechsteinii*).

Potential to support roosting bats	Equivalent tree categories within Collins (2016)	Description
		within an area of woodland is more likely to be occupied by bats than one adjacent to large areas of hard standing (as the bats would use the woodland for feeding and potentially roosting). Potential examples of high potential features are: • a south-facing opening on a tree trunk that appears to form a significant wound within the tree, with uncluttered drop zone and good connectivity to other areas of suitable habitat; or • a gap below a ridge tile that provides a potential point of access to a pitched roof, with marked cleaner tile below indicating potential use by bats.
Moderate	Moderate	A structure or tree with one or more potential roost sites that could be used by bats due to their size, shelter, protection, conditions and surrounding habitat but unlikely to support a roost of high conservation status. A feature/structure that would be ideal for bats but where other factors such as sub-optimal habitat limit the potential to be used by bats.
Low	Low	A tree/structure containing features where opportunistic use by individual bats cannot be ruled out but where the roost sites are of limited potential as they do not provide enough space, shelter, protection, appropriate conditions (e.g. temperature, humidity, light levels or disturbance) and/or lack suitable surrounding habitat to be used on a regular basis or by larger numbers of bats. For example often metal warehouse structures with suitable access/egress points will be classed as having low potential to support roosting bats.
Negligible	Negligible	A tree/structure which is considered to lack any features suitable for use by roosting bats.

14.4.3 It should be noted that the initial assessment of potential considers only the potential to support any bat roost. The significance of any roost will depend on the species, number and use (e.g. maternity, hibernation) identified by subsequent survey.

Assessment of buildings/structures for potential to support roosting or swarming bats

14.4.4 Buildings/structures (including natural structures such as caves and man-made features such as adits) identified as requiring survey (according to the criteria provided in Table 7) should be given a unique reference code as described in Section 3 and assessed for their potential to support bat roosts and/or act as a swarming site. Surveys should include bridges and tunnels passing over/under the route of the Proposed Scheme.

14.4.5 Internal and external inspection of the structure for potential bat access/egress points and signs of bat activity should be undertaken and recorded as shown in Figure 2. A drawing should be made to show the layout of the structure, and the location, aspect and height of any features/signs of bats and potential access/egress points.

14.4.6 Digital photographs should be taken (cross-referenced to a plan) to record all features within the exterior and interior of the structure for future reference. Photographs should be taken of any evidence of bats (such as distribution of droppings and urine staining). However, all photography should ensure that it does not result in the disturbance of any bats currently in-situ.

14.4.7 Reference should be made to the glossary of architectural terms within the Bat Workers Manual (2004) when describing the construction of buildings.

14.4.8 Where droppings are found and cannot be identified definitively a small sample (considered to represent droppings from a single species) should be collected and sealed in a plastic bag marked with the following details:

- date sample collected (day/month/year);
- survey location reference (see Section 3 of this technical note);
- GPS coordinates;
- suspected species; and
- surveyor name.

14.4.9 The sample should subsequently be stored in a cool, dry place. DNA analysis will be conducted where appropriate on these samples to help confirm species present.

Figure 2: Standard information to be recorded during roost assessments of buildings and built structures

Box 8.4 Standard information to be recorded in preliminary roost assessments of buildings and built structures

Evidence of use by bats:	**Features of the building or built structure:**
Location and number of any live bats. Location and number of any corpses or skeletons. Location and number of droppings. Notes on relative freshness, shape and size of droppings. Location and quantity of feeding remains. Location of clean, cobweb-free timbers, crevices and holes. Location of characteristic staining from urine and/or grease marks. Location of known and potential access points to the roost. Location of the characteristic smell of bats if no other evidence is recorded.	Type. Age. Aspect. Wall construction, in particular the type of brick or stone used to build the walls and whether it has cavity walls or rubble-filled walls. Form of the roof, in particular the presence of gable ends, hipped roofs, etc. and the nature and condition of the roof covering. Presence of hanging tiles, weather-boarding or other forms of cladding. Nature of the eaves, in particular if they are sealed by a soffit or boxed eave and the tightness of the fit to the exterior walls. Presence and condition of lead flashing. Gaps under eaves, around windows, under tiles, lead flashing etc. Presence and type of roof lining. Presence of roof insulation. Presence of water tanks in loft (note if covered or uncovered). Structure of the roof including the truss type, age and nature of timber work. Information or evidence of work having been undertaken that could affect use of the structure by bats.

Source: Bat Surveys – Good Practice Guidelines 2nd edition (Hundt, 2012).

14.4.10 Where ever possible and safe to do so, surveys should access all areas including cellars/underground structures and loft spaces. High-powered torches with red filters, binoculars and endoscopes should be used to investigate all accessible areas. Where there

are any constraints to the survey these should be clearly identified in the survey notes and consideration given to the effect these constraints may have had on the results obtained.

14.4.11 Each building/structure should be classified according to its potential to support roosting bats during the active season as confirmed, high, moderate, low or negligible based on Table 7.

14.4.12 In addition surveyors should, where possible, also give an indication of the type of roost the building structure is considered most likely to support based on current evidence (e.g. summer maternity roost, transitory roost, feeding perch, swarming site or hibernation roost) and/or the number of bats it is considered to have the potential to support on a three point scale of small, medium or large. It is acknowledged that for many features classification under these criteria may not be possible based on initial inspection alone.

14.4.13 Where buildings are confirmed roosts or are considered to have moderate or high potential to support a roost; or where a full inspection cannot be undertaken due to access restrictions (e.g. unsafe structure), then subsequent evening emergence and dawn re-entry surveys will be required. Given the evolving nature of the design, the requirement for emergence survey in relation to buildings applies in the first instance to all buildings within the survey scope (i.e. with the exception of urban areas, those located within the land required for construction of the Proposed Scheme or within a 100m buffer either side of the current boundary of the land required, or specific features within a 500m buffer where potential significant effects are anticipated). As design stabilises professional judgment may be applied to limit survey outside of the land required for the construction of the Proposed Scheme to those locations where there is considered to be the potential for significant effects.

14.4.14 No further survey is required of buildings/structures assessed to have low or negligible potential but sufficient information will need to be collected to give confidence to this assessment. As a precaution the procedure for demolition of low potential buildings is likely to include reasonable avoidance measures, such as toolbox talks for contractors and procedures for dealing with chance finds of bats.

14.4.15 Each building/structure subject to initial assessment should also be assessed for its potential to support hibernating bats or act as a swarming site. Assessment should in this case simply classify sites as having potential for hibernation/swarming or lacking hibernation/swarming potential. All buildings/structures identified as having hibernation or swarming potential will require further survey as described later in this section.

Assessment of trees for potential roost features (PRFs)

14.4.16 Assessment should be based on the approach to identifying PRFs set out in section 6 of Collins (2016). As a general rule, in the first instance, all trees with a diameter at breast height (DBH) of 0.25m or more within the land required for the construction of the Proposed Scheme or within a 100m buffer either side of it should be subject to survey from ground

level by a competent ecologist with knowledge of tree roosting in bats. Binoculars will be used to inspect the canopy of the tree for evidence of features that may be used by bats, with each feature graded based on its potential to support roosting bats as identified in Table 7. A survey sheet does not need to be completed where there is negligible potential.

14.4.17 Trees less than 0.25 DBH may also support bat roosts on rare occasions[58]. Professional judgement should be used to identify such trees, based on specific tree features that may be present, for inclusion in the surveys.

14.4.18 All trees should be given unique reference codes (see Section 3 of this technical note), with the location mapped and cross referenced to photographs taken. Preliminary surveys of trees should, ideally, be undertaken in the December to March optimal period before trees come into full leaf. Where this is not possible the limitations on survey should be acknowledged and where leaf cover is considered to significantly obscure initial inspection then trees should be given a precautionary 'high' grading, triggering the requirement for future climb-and-inspect survey.

14.4.19 In addition surveyors should, where possible, also give an indication of the type of roost the feature is considered most likely to support based on current evidence (e.g. summer maternity roost, transitory roost, feeding perch, swarming site or hibernation roost) and/or the number of bats it is considered to have the potential to support on a three point scale of small, medium or large. It is acknowledged that for many features classification under these criteria may not be possible based on initial inspection alone.

Climb-and-inspect survey (trees)

14.4.20 Any trees where the presence of a roost has been confirmed during the initial assessment will not be subject to climb-and-inspect survey and should instead progress directly to emergence survey.

14.4.21 All standard trees in hedgerows and farmland (i.e. those not present within woodland) that are considered to contain the following features will be subject to further inspection:

- trees identified during the initial inspections as containing features with high or moderate potential to support roosting bats during the 'active' period; or
- features with potential to support hibernating bats.

14.4.22 It is acknowledged that not all trees will be considered safe to climb and for all trees where this is true a clear record should be made. In addition, where the only features on a tree triggering the requirements for climb-and-inspect survey are either ivy cover or relatively open features that can be viewed fully from the ground using a torch (e.g. a callus roll) then no climb-and-inspect survey is required.

[58] Andrews, H. and Gardner, M. (2016), *Bat Tree Habitat Key – Database Report*, AEcol, Bridgewater.

14.4.23 All inspections should be conducted either by a trained tree climber who is also a Natural England licensed bat worker, or by a tree climber under the direct supervision of a licensed bat worker. In order to minimise the risk of disturbance during inspections all tree climbers who are not licensed bat workers will be briefed by a bat worker who is competent in undertaking tree inspections.

14.4.24 Climb-and-inspect surveys should, ideally, be undertaken between May and September when bats are more likely to be present. They will continue to provide useful information regarding the exact nature of features outside of this period. However, a more precautionary approach should be taken to the scoping out of further survey when inspections are conducted outside of this ideal period. Based on the results of the climb-and-inspect survey initial gradings will be reviewed and re- graded where necessary according to Table 7.

14.4.25 Where confirmed evidence of bats is found during the climb-and-inspect survey, or features cannot be investigated in full, emergence/re-entry surveys will be required. Emergence survey will also be conducted on the following:

- all trees containing high potential features (based on the outcome of the further inspection) which will either be subject to works or may be subject to potentially significant effects (e.g. through severance of habitat features utilised during foraging, commuting or navigation; or disturbance through lighting or noise); and
- all trees containing moderate potential features which could not be investigated fully during climb-and-inspect surveys.

14.4.26 Features assessed to have low or negligible potential to support roosting bats (following inspection and re-grading) will be scoped out of further survey work.

14.4.27 Should climbing surveys be deemed unsafe or otherwise not possible, any trees containing either high or moderate potential features should be subject to dusk emergence and dawn re-entry surveys.

Dusk emergence and pre-dawn re-entry surveys

14.4.28 The minimum level of survey for buildings/structures and trees requiring additional survey in the form of evening emergence and dawn re-entry surveys is detailed in Table 8. In each case the level of survey for the tree, building or structure in question will be defined by the highest potential feature which it supports (i.e. survey effort for a tree containing both high and moderate potential features will be three dusk emergence and/or pre-dawn emergence surveys). It should be noted that trees containing moderate potential features should only

be subject to emergence survey where it was not possible to fully inspect these features during climb-and-inspect surveys. Surveys should be undertaken between May and August[59].

Table 8: Minimum number of emergence and re-entry survey visits for high and moderate potential trees and buildings

High bat roosting potential	Moderate bat roosting potential
Three dusk emergence and/or pre-dawn re-entry surveys during May to September, with at least two of the surveys between May and August.	Two dusk emergence and/or pre-dawn re-entry surveys during May to September, with at least one of the surveys between May and August.

Source: Bat Surveys – Good Practice Guidelines 3rd Edition (Collins, 2016).

14.4.29 In each case at least one of the surveys should be a pre-dawn re-entry survey. In addition, it should be noted that two surveys carried out within the same 24 hour period only constitutes one survey (i.e. a dusk emergence immediately followed by a pre-dawn re-entry only represents a single survey visit). Wherever possible, visits should be undertaken a minimum of two weeks apart.

14.4.30 Once the minimum standard is completed consultants undertaking survey work should consider the requirement for additional visits on a case by case basis.

14.4.31 Surveyors will use frequency division, time expansion or full spectrum echolocation detectors.

14.4.32 Detectors will be either recording detectors or be connected to a digital recording device, allowing recordings to be made as .WAV files or in a format that can be converted to .WAV format. This will enable calls to be analysed in suitable sound analysis software.

14.4.33 Static monitoring devices may be utilised as a mobile recording device during emergence surveyors. However, in all cases surveyors should also be equipped with a stand-alone detector and headphones. Static monitoring devices should only be used to replace surveyors during emergence surveys at locations where there are health and safety issues.

14.4.34 Surveyors are to be positioned in sufficient numbers that all potential roost features can be seen by at least one surveyor. All surveyors will be briefed prior to the start of survey as to the findings of the preliminary assessment and shown the presence of any potential access/egress points. Surveyors will remain at their survey station throughout the emergence survey period (i.e. surveyors moving between multiple roost features during a survey represents insufficient coverage). Dusk emergence and pre-dawn re-entry surveys should not be combined with activity surveys.

14.4.35 In some locations consultants undertaking survey may find it useful to conduct emergence survey of trees or buildings which contain suitable features and occur in close proximity as part of a single larger survey. This approach is acceptable assuming that the number of

[59] Where access constraints and exceptional weather are a factor, consultants undertaking survey should consider the merits of conducting surveys into September/October with repeat visits the following year. In many cases, the minimum requirement in relation to emergence survey will be achieved through a combination of visits from both survey years.

surveyors utilised remains sufficient to ensure that all potential roost features are visible by at least one surveyor at all times.

14.4.36 Evening emergence surveys are to be undertaken from 15 minutes before sunset until two hours after sunset; and pre-dawn re-entry surveys undertaken from two hours before sunrise until sunrise. Where bats are still active at sunrise the time should be extended by 15 minutes after sunrise. A record of weather conditions including air temperature, cloud cover and wind speed is to be made at the start and end of the survey period together with casual recordings made of any changes in weather conditions for the duration of the period, such as rain showers, and sunset and sunrise times. During the survey, a record of the number of bat passes of each species is to be made together with additional information such as direction of flight, emergence/re-entry point and activity recorded. Data is to be submitted in the approved proforma format with supporting maps and documentation.

14.4.37 Following survey work, all recordings are to be analysed by a competent ecologist who is experienced in using call analysis software to confirm species (where possible) and number of passes made. All recordings are to be retained for future reference.

14.4.38 All emergence surveys should be conducted during suitable weather conditions as defined in Collins (2016).

Back tracking surveys

14.4.39 At locations where a group of trees meet the criteria for further survey, it may be appropriate to utilise back tracking survey as an alternative to emergence/pre-dawn re-entry surveys in order to locate roosts and gain a greater understanding of the bat assemblage supported by these features. This technique should only be used where the trees are sufficiently spaced to allow clear sight lines of the bats. It should not be used in dense woodland.

14.4.40 Collins (2016) explicitly acknowledges that establishing absence of bats in trees is very difficult and that, given the ecology of tree-roosting bats, all trees with bat rooting potential should be considered a resource that will be used at one time or another by tree-roosting bats.

14.4.41 To assist in meeting the requirements of both impact assessment and informing the need for licensing in relation to groups of trees and woodland blocks, the following method will be used.

14.4.42 Trees within the land required for the construction of the Proposed Scheme plus 100m buffer will be subject to scoping assessments to establish their potential roost feature (PRF) status as described above. Low potential trees as defined in Collins (2016) as those containing no PRF's or PRF's unlikely to support more than opportunistic use by small numbers of bats and these will be excluded from further survey.

14.4.43 Tree climbing surveys will be undertaken on moderate or high potential trees to establish if roosts are present and confirm if assessment is correct (e.g. aerial inspection may reveal PRF's are not suitable).

14.4.44 Where multiple moderate or high potential PRF's and/or roosts are confirmed, a perimeter will be established around the relevant group of trees (where only a small number of roosts or potential roost are identified standard emergence surveys would apply).

14.4.45 Back tracking surveys utilising a minimum two dusk/dawn or dawn/dusk surveys would be conducted along this perimeter with surveyors spaced at intervals no greater than 50m. Surveyors will backtrack any commuting routes to potential roost sources. Surveys to be undertaken May to September with at least one of the surveys occurring during May to August.

14.4.46 Back tracking surveys at dusk will start 15 minutes before sunset until it is too dark to observe bats or when the source roost(s) have been found. Dawn surveys will start two hours before sunrise and cease when either bats are no longer active or the source roost has been found.

14.4.47 Static detectors will be placed in hedges, ditches, other linear features or groups of trees for a minimum of ten days (where suitable conditions exist - e.g. equipment can be secure). This information would inform back tracking surveys by identifying species, activity (e.g. social calls, feeding) and potential roost sites or commuting routes.

14.4.48 In large complex woodlands this approach will identify significant roosts (e.g. maternity and satellites) but is unlikely to identify all trees used by bats in low numbers or on a transient basis.

14.4.49 In these circumstances the identified roosts, plus the overall woodland resource available as indicated by the distribution of PRFs within the woodland, would be used to identify the species present, the type of roosts present and the approximate size of the populations present. This data will inform both the impact assessment and the mitigation required to maintain the favourable conservation status of the species.

14.4.50 Where Annex II species are detected, or there is a requirement to gather additional information (e.g. to differentiate Myotis species where a rarer species such as Alcathoe bat may be suspected), trapping or other advanced bat licence techniques may be considered.

Surveying woodlands for bats

14.4.51 The Bat Conservation Trust survey guidance explicitly acknowledges that establishing the absence of bats in trees is very difficult and that, given the ecology of tree-roosting bats, all trees with bat roosting potential should be considered a resource that will be used at one time or another by tree-roosting bats.

14.4.52 On that basis and given the large number of trees that are present in woodland, the survey method for bats in woodlands at the EIA stage does not attempt to identify all individual roosts. It is assumed that if a woodland contains bats during the pupping season, maternity

roosts will be present. At this stage, woodland surveys will establish the potential roost features present through tree inspection to identify the overall roost potential in the wood. The species present and their activity patterns will be established through the use of transects and static detectors.

14.4.53 Woodlands that are assessed as having low to moderate suitability for bats based on quality and quantity of the roost and feeding resource and ecological position of the wood will require three transect surveys: one in spring (April and May), one in summer (June to August) and one in autumn (September and October). Woodlands that are assessed as being of high value to bats require monthly transects between April and October. For all woodlands, one visit in the summer period should comprise a dusk and pre-dawn visit within 24 hours.

14.4.54 Static detectors should be deployed at a minimum density of one per transect in low or moderate value woodlands and two per transect in high value woodlands. Detectors must be left in situ for five days on each of the active transects in appropriate weather conditions.

14.4.55 A precautionary assessment of the woodland resource will be derived from the quality and quantity of potential roost features within the woodland, the species composition and levels of activity as derived from surveys.

14.4.56 Where datasets indicate that a woodland contains a diverse assemblage of high value bat species and it is likely to be subject to significant effects, or where Annex II species are found to be present, consideration will be given to radio tracking studies under a separate project licence.

Bat activity surveys (walked transect)

14.4.57 Within each 10km section of the route, a minimum of 3km of bat activity transect should be undertaken. This does not need to be a continuous 3km and can be divided into sections to target features of particular interest and potential impact within and outside the land required for the construction of the Proposed Scheme, based on review of desk study data, aerial mapping and Phase 1 habitat survey data (where available). Where the 10km section contains significant extents of bored tunnel the minimum effort may be reduced.

14.4.58 In areas of high quality habitat for bats or where significant effects are otherwise considered likely (e.g. as a consequence of severance, loss of foraging habitat or disturbance), the consultant undertaking the survey is to undertake additional transect routes (i.e. in addition to the minimum of 3km within every 10km section) to assess likely significant effects on bats.

14.4.59 The aim of the surveys is to give an indication of species and numbers of bats utilising habitat within and in the vicinity of the land required for the construction of the Proposed Scheme and to give an indication of existing features within the landscape that may be important in bat foraging, navigation and orientation and may be adversely affected as a consequence of the construction and/or operation of the Proposed Scheme.

14.4.60 The transect routes should in general focus on features which may act as bat flight lines (such as hedgerows and watercourses) which may be severed or adversely affected as a

consequence of construction and/or operation of the Proposed Scheme and potential roost sites such as bridges, buildings and mature trees within the land required for the construction of the Proposed Scheme and a 100m buffer either side of it.

14.4.61 Features outside the land required + 100m buffer are only to be included where they are considered to be of value in identifying and assessing significant effects on bats (in particular as a consequence of severance).

14.4.62 Transect routes should be planned by a competent bat ecologist utilising aerial photographs, Phase 1 habitat survey data and site photographs to identify major habitat types and likely feeding areas and commuting routes. A minimum of 10 listening station stops (three to five minutes per stop) should be incorporated per transect route. Each transect route should take two to three hours to complete (Collins, 2016). Time spent at each stop will depend on the total number of stops within the transect.

14.4.63 Prior to conducting the first survey visit at least one member of the survey team should have visited the transect route during daylight hours in order to ensure that access constraints (e.g. fencing, hedges and other obstacles) have been considered and confirm that the locations of listening station stops are appropriate. If one of the survey team is already familiar with the site from previous visits for other surveys then no additional visit will be required. Once the transect route and listening station stops have been selected, transects will be walked at a steady speed by a competent ecologist using a bat detector either capable of direct recording or connected to a recording device.

14.4.64 All surveys should be conducted during suitable weather conditions as defined in Collins (2016).

14.4.65 Surveyors will use frequency division, time expansion or full spectrum echolocation detectors. Detectors will be connected to a digital recording devices, allowing recordings to be made as .WAV files or in a format that can be converted to .WAV format. This will enable calls to be analysed in suitable bat analysis software.

14.4.66 Static monitoring devices may be utilised as a mobile recording device during activity survey. However, in all cases at least one surveyor should also carry a hand held detector (and headphones) with frequency division or time expansion capability and linked recording device.

14.4.67 Transect surveys are to be undertaken from sunset until two hours after sunset or until the full transect length has been walked (whichever is later) and for at least two hours before sunrise until sunrise. A record of weather conditions including air temperature, cloud cover and wind speed is to be made at the start and end of the survey period together with casual recordings made of any changes in weather conditions for the duration of the period, such as rain showers, along with sunset and sunrise times. During the survey, a record of the number of bat passes of each species is to be made together with additional information such as direction of flight, any emergence/re- entry points and activity recorded.

14.4.68 Where access allows each activity transect should be repeated as a minimum once a month between April and October at least one of the surveys comprising dusk and dawn surveys within one 24-hour period (i.e. dusk activity followed immediately by pre-dawn survey equates to one visit). The start point and direction of transects should be varied between visits with the location, direction of walking and time of start noted in survey data.

14.4.69 Where habitat quality is high, or there is considered to be the potential for significant effects on bats then the requirement to undertake additional visits (i.e. above the one per month minimum requirement) should be considered.

14.4.70 During activity surveys, where bat roosting is confirmed through observation, additional emergence/re-entry surveys may be required and should be undertaken in line with the methodology outlined above.

14.4.71 If Annex II bat species are recorded or suspected, the scope of additional survey work should be agreed with HS2 Ltd through the deviation request process.

14.4.72 Following survey work, all recordings are to be analysed by a competent ecologist and confirmation of species and number of passes made. All recordings are to be retained for future reference.

Bat activity (car-based transect)

14.4.73 In those areas of significant land access refusals, driven transects on local roads should be utilised where appropriate to maximise available baseline data.

14.4.74 A methodology for car based transects is provided in Appendix C.

14.4.75 It should be noted that prior to conducting any car based transects consultants undertaking the survey must submit a risk assessment for the proposed survey. It will be the responsibility of the consultant undertaking the survey works to notify the local highways authority and any other necessary parties (including the Police as appropriate).

14.4.76 This method should not be used in busy urban areas as it is unlikely to be acceptable on health and safety grounds or in areas where access has been granted.

Automatic detectors

14.4.77 Within each 10km of route requiring bat activity surveys, a minimum of two automated echolocation detectors are to be installed at suitable points (e.g. at hedgerow crossings) along the route alignment as determined by a competent ecologist who has experience in their use, in order to provide additional data to assist in assessing the impact of habitat severance.

14.4.78 Consultants undertaking the surveys should also consider the requirement for additional echolocation detectors (i.e. in addition to the minimum of two per 10km route section) at suitable points to assist in determining the impact of habitat loss, severance or activity in the vicinity of known/suspected roosts.

14.4.79 Where only the minimum number of automated detectors are deployed they should be placed at least 2km apart unless the landscape pattern means that there is good reason to have closer spacing. Where additional detectors are utilised these may be deployed as required in order to help in the assessment of likely significant effects on bats.

14.4.80 Detectors should be in place and recording for at least five consecutive nights per month between April and October. Detectors will need to be positioned in water-proof cases and checked on a monthly basis to collect data.

14.4.81 To give consistency across hardware, automated detectors should be as a minimum Titley Anabat SD2 or Wildlife Acoustics SM2BAT+ recording in zero crossing mode although full spectrum recorders (such as Elekon batlogger C's) will be preferred.

14.4.82 Analysis should be undertaken using suitable packages for zero crossing or full spectrum calls and bat calls recorded should be tabulated against time and the location of the recording device.

14.4.83 All sound analysis must be subject to quality control measures that include a 10% sample of all pipistrelle calls and a manual check of all non-pipistrelle calls.

14.4.84 Auto Identification programmes can be used for static and manual detector outputs but only if the same QA procedures are used. The total number of files, the total number of files checked and the total number of each correction made should be logged and reported in the results section. The implications of the errors made by the automatic identification software should then be presented in the results/discussion.

Hibernation site surveys

14.4.85 If initial survey identifies buildings/structures with the potential to act as bat hibernation sites, these will need to be surveyed by an ecologist with a Natural England licence to disturb hibernating bats.

14.4.86 Two visits are required, ideally one in mid-January and one in mid-February, although December visits are also acceptable. At sites with a moderate or high likelihood of hibernating bats being present and particularly where bats could be concealed in crevices, consideration should be given to the use of automated detectors. These can be deployed for a minimum of two weeks in each month from December to February.

14.4.87 The site should be searched systematically from the entrance, with the locations of any bats seen marked on a plan of the site. Before entering sites, surveyors should familiarise themselves with White Nose Syndrome and procedures for decontamination and recording. Details are provided on the Bat Conservation Trust[60] website and should be checked for updates.

[60] Bat Conservation Trust, *White-nose syndrome*. Available online at: http://www.bats.org.uk/pages/about_bats-white-nose_syndrome-586.html.

14.4.88 Careful inspection for droppings or oil staining around cracks and crevices, including rock piles, may also yield evidence of use by bats. Detailed records will be made of the location of any bats and/or signs of bats identified. In addition accurate temperature (°C) and relatively humidity (%) readings should be taken during each visit. It is assumed that a full description of the potential hibernation site, including details of construction and potential perching points will have been made as part of the initial assessment.

Autumn swarming survey

14.4.89 If initial survey or desk study/consultation identifies potential autumn swarming sites, the following survey methodology should be applied in line with Collins (2016).

14.4.90 At least five nights of survey with an automated/static detector in each month between mid-August and end of October should be undertaken.

Advanced licence bat survey techniques

14.4.91 If more detailed survey work including radio-tracking is required, this will need to be agreed with HS2 Ltd via the deviation request process. Use of such methods will only be accepted where there is no alternative suitable means of collecting these data. In these circumstances an application for a project specific licence to undertake these surveys would need to be submitted to Natural England.

14.4.92 If harp trapping is used surveys should be led by a surveyor holding a Class 4 Natural England Survey Licence. The team should also include at least one other competent ecologist who has experience in handling bats and identifying bats in the hand. Sites where a substantial amount of bat capture is expected should be surveyed by teams of at least four ecologists. No harp trapping will take place from the beginning of June to end of July when bats are considered likely to be heavily pregnant or with very young pups.

14.5 Survey programme and effort

14.5.1 Timing of survey work is detailed in the survey methodology section above, summarised in Table 9 below. The balance between tree-climbing inspections and emergence surveys should be determined based on an assessment of the most effective approach in a particular circumstance.

Table 9: Summary of bat survey programme and effort

Survey	Programme	Effort[61]
Building inspections.	Year round (optimum period between May and September).	Any buildings identified during the habitat surveys as likely to be suitable for occupation by bats and which may be affected by the Proposed Scheme (demolition, disturbance, modification) should be

[61] Access constraints mean that the full survey effort will not be achieved at all sites selected for survey.

Survey	Programme	Effort[61]
		investigated in more detail for evidence of use by bats.
Assessment of trees for potential to support roosting bats.	Year round (assuming a precautionary approach is adopted during periods of dense leaf cover). Optimum period December to March.	Any tree of 0.25m DBH or above within the land required for the construction of the Proposed Scheme and a 100m buffer either side of the land required and any other significant trees will be investigated in more detail for evidence of use by bats.
Tree climber inspections.	Year round (optimum period between May and September).	Trees with moderate or above potential to support roosting bats.
Dusk emergence and dawn re-entry surveys.	May to September.	High roosting potential: three dusk emergence and or pre-dawn emergence between May to September, with at least two of the surveys between May and August. However, the initial climbed inspection can replace the first of these surveys if carried out at the start of the bat activity season. Emergence surveys must replace any remaining climbed inspections if the presence of bats is confirmed. Three emergence surveys must be carried out on trees that are unsafe to climb or where roost features are difficult to inspect. Moderate roosting potential two dusk emergence and/or pre-dawn surveys May to September, with at least one of the surveys between May and August.
Activity surveys.	June to August.	Where access allows each activity transect should be repeated as a minimum on three occasions between June and August with at least one of the three surveys comprising dusk and dawn surveys within one 24-hour period (i.e. dusk activity followed immediately by pre-dawn survey equates to one visit). The consultant undertaking surveys should consider the requirement for additional survey visits in areas of particularly suitable habitat.
Automated detector survey.	May-October.	Detectors should be in place and recording for at least five consecutive nights per month between May and October and checked on a monthly basis to collect data.
Autumn swarming.	August to October.	At least five nights of survey with an automated/static detector in each month between mid-August and end of October.
Hibernation survey.	January-February	Two visits are required, one in mid-January and one in mid-February. At moderate and high potential sites consideration should be given to the use of automated detectors deployed for a minimum of two weeks in each month from December to February.
Car based transect	April-June and September-October	Only to be used in rural areas where no other access is available.

15 Otter

15.1 Introduction and guidelines

15.1.1 There is the potential for adverse effects on otter (Lutra lutra) particularly where watercourses pass through or in close proximity to the land required for the construction of the Proposed Scheme. Given the on-going expansion in the distribution of the otter, it is considered important to also identify those which are suitable for use by otter in the future.

15.1.2 The survey will take into account the use of terrestrial habitat by otter including location of both actual and potential holts (i.e. underground resting sites) and of couches (i.e. above-ground resting sites) and linear routes that may be important for movement between watercourses.

15.1.3 The proposed survey methodology is based upon the guidance provided in the Design Manual for Roads and Bridges (DMRB) Volume 10 Section 4 Part 4 (Highways Agency, 1999[62]) and takes account of information in Chanin 2003[63] and Chanin 2005[64].

15.2 Qualifications and experience

15.2.1 Habitat assessment and selection of sites for further survey is to be conducted by persons with awareness of the range of habitats utilised by otter, including knowledge of terrestrial features utilised during breeding.

15.2.2 All surveyors should have experience of the following:

- identification of otter field signs;
- differences between signs of otter and other species which can be confused with otter, including mink;
- otter behaviour and habitat requirements; and
- identifying potential impacts of seasonal conditions or weather conditions on the validity of survey results.

15.2.3 An otter specialist is to lead surveys wherever possible due to the complexity of finding and identifying holts and couches in particular when distant from watercourses.

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[62] Highways Agency (1999), *Design Manual for Roads and bridges (DMRB), Volume 10, Section 4, Part 4. Nature Conservation Advise in relation to Otters.* Highways Agency, London. Available online at: https://www.standardsforhighways.co.uk/dmrb/.

[63] Chanin, P. (2003), *Monitoring the Otter (Lutra lutra).* Conserving Natura 2000 Rivers Monitoring Series No. 10, English Nature, Peterborough.

[64] Chanin, P. (2005), *Otter surveillance in SACs: testing the protocol.* English Nature Research Reports - Number 664, English Nature, Peterborough.

15.3 Licensing requirements

15.3.1 No licence is required to conduct otter survey assuming that care is taken to avoid disturbance of potential couches and holt locations. No survey that would result in disturbance of otter, or their places of rest, is proposed as part of the current survey. Where monitoring of holts is required, non-invasive techniques such as the use of appropriately placed infra-red cameras will be utilised.

15.4 Screening for survey and defining the survey area

15.4.1 Initially a review of desk study data, OS mapping and aerial photography is to be undertaken to identify all watercourses and water bodies that fall within a 100m buffer of the land required for the construction of the Proposed Scheme and any others where there is considered to be the potential for the Proposed Scheme to result in significant adverse effects on otter. Where available, results of the Phase 1 habitat survey, River Corridor Survey and ditch and pond surveys will inform this screening exercise.

15.4.2 It is expected that all watercourses which pass within a 100m buffer of the land required for the construction of the Proposed Scheme will require habitat assessment. Watercourses/water bodies would only be scoped out where significant barriers to movement occur between this feature and the land required for construction of the Proposed Scheme.

15.4.3 A walkover of each site selected for survey will be conducted by a competent surveyor and a decision taken on the need for subsequent detailed survey. This assessment should include consideration of each site against the following criteria:

- proximity to the land required for construction of the Proposed Scheme;
- presence of significant barriers to dispersal and movement through the territory;
- habitats present and suitability for use by otter (including terrestrial habitats);
- adjoining land use;
- level of disturbance;
- features of watercourse/water body (estimated depth, level of flow, width of channel);
- connectivity with other areas of suitable or sub-optimal habitat; and
- pollution.

15.4.4 Surveyors should have achieved the CIEEM competency standard for otters[65].

[65] Chartered Institute of Ecology and Environmental Management (2013), *Competencies for Species Surveys: Eurasian otter CIEEM,* Winchester.

15.5 Survey methods

Aquatic/riparian habitats

15.5.1 For watercourses selected for detailed survey, initially a 2km section either side of the boundary of the land required for the construction of the Proposed Scheme should be surveyed. Where a confluence with a river is reached more than 1km from the boundary of the land required and there are no signs of otter activity in the vicinity of the confluence, the survey should be terminated at this point.

15.5.2 Surveys conducted during the winter (after November) should utilise a revised survey extent of a minimum of 300m either side of the boundary of the land required for the construction of the Proposed Scheme. The reduction in extent follows correspondence with Natural England. The reduced survey effort is appropriate given that a commitment has been made that the undertaker will ensure that the Proposed Scheme maintains safe passage for otter at all watercourses potentially suitable (i.e. including those yet to be repopulated by otter).

15.5.3 Where possible both banks should be surveyed. Where necessary spot checks should be conducted at suitable publicly accessible areas within 5km of the land required for the construction of the Proposed Scheme (Highways Agency, 1999).

15.5.4 For water bodies, the survey should include all areas that fall within a 100m buffer from the land required for the construction of the Proposed Scheme and a minimum 300m section either side of this (Highways Agency, 1999).

15.5.5 For all sections of aquatic/riparian habitat subject to survey, all evidence of otter and other notable species such as water vole and mink should be recorded. This should as a minimum include the number and location of the following field signs:

- natal holts, holts and potential holt sites (using the criteria provided in Appendix D);
- couches;
- spraints;
- anal jelly;
- tracks/footprints;
- silt/sand heaps; and
- slides.

15.5.6 All field signs of otter, along with those of any other notable species (in particular mink and water vole) should be provided with GPS derived grid coordinates accurate to less than 5m. Where topography and vegetation structure may have reduced the accuracy of records below this level, this information should be noted.

15.5.7 When searching for potential holt sites the criteria devised by Chanin (2012) provided in Appendix E should be utilised as the basis for identifying potential holt sites and determining whether or not they are in use.

15.5.8 Where the presence of otter is confirmed and significant adverse effects are likely, there may be a requirement to extend the extent of survey into other adjacent watercourses (which may have been scoped out at an earlier stage) and for the use of additional survey methods including use of camera traps.

Terrestrial habitat

15.5.9 Where land required for the construction of the Proposed Scheme is located within 100m of a watercourse or water body that is confirmed as being utilised by otter, a review of aerial photography and walkover survey (where required) should be conducted to check for the presence of any features within the land required that may be utilised as couches, resting places or natal holts.

15.5.10 The following criteria devised by Chanin (2012) should be utilised to identify potential otter breeding sites:

- any single area of extensive concealing habitat (woodland, scrub, reedbed);
- which is greater than 1ha in area and within 100m of a watercourse; and
- any combination of extensive concealing habitats which are within 100m of one another, total at least 1ha and are within 100m of a watercourse.

15.5.11 For all potential breeding sites identified using these criteria a site visit should be conducted by a competent otter surveyor to check for signs of breeding activity (e.g. well used paths, play areas, or large accumulations of spraint). During this visit their overall suitability should be scored on a scale of 0= unsuitable to 5 = highly suitable taking into consideration the criteria for assessing cover and suitability of food shown in Appendix D devised by Chanin (2012).

15.5.12 The location of any such feature identified should be recorded, along with details of the feature and associated habitat (e.g. large wood pile within area of semi-natural woodland).

15.5.13 In addition, the survey should look to identify and map any linear features that may be important in the movement of otters between adjacent watercourses.

15.6 Survey programme and effort

15.6.1 Where access restrictions allow, a total of four survey visits should be conducted at approximately three-monthly intervals. However, where no habitat suitable for the creation of holts or couches is present within the land required for the construction of the Proposed Scheme then survey may be curtailed once the presence of otter has been confirmed.

15.6.2 Survey should not be conducted during or following periods of heavy rainfall, as field signs will have been washed away. In general where possible survey visits should be timed to avoid survey when water levels are high.

16 Water vole

16.1 Introduction and guidelines

16.1.1 Survey for water vole (*Arvicola amphibius*) will need to take account of all watercourses that pass through or in close proximity to the land required for the construction of the Proposed Scheme including canals, where populations are thought to be surviving better than on rivers.

16.1.2 The proposed approach will follow the Water Vole Mitigation Handbook[66] survey methodology, taking into account current Natural England advice[67].

16.2 Qualifications and experience

16.2.1 All initial scoping and habitat assessment work should be conducted by persons with previous experience of the range of habitats utilised by water vole and of field signs indicating potential presence of water vole.

16.2.2 A detailed search of the survey area in question should be undertaken by a competent water vole surveyor. This should be a surveyor who has undertaken sufficient similar surveys in the past to enable a suitable level of confidence in identifying the field signs of water vole.

16.2.3 Surveyors should have achieved the required standard in the CIEEM competency for water vole[68].

16.3 Licensing requirements

16.3.1 No licence is required to survey for water vole. Care should be taken during survey not to disturb water vole if present.

16.4 Screening for survey and defining the survey area

16.4.1 Initially review of desk study data, aerial photography and habitat mapping should be undertaken to identify and map all areas of habitat potentially suitable to support water vole

[66] Dean M, Strachan R, Gow D and Andrews R (2016), The Water Vole Mitigation Handbook (Mammal Society Mitigation Guidance Series), Eds. Fiona Mathews and Paul Chanin. The Mammal Society, London.

[67] Natural England (2008), *Water voles – the law in practice.* Guidance for planners and developers (NE 86). Natural England, Peterborough.

[68] Chartered Institute of Ecology and Environmental Management (2013), *Competencies for Species Surveys: Water Vole*, CIEEM, Winchester.

that are located within the land required for the construction of the Proposed Scheme, or within a 500m buffer of the boundary of the land required. This initial assessment should include identification of all watercourses, ponds and lakes within this extent, and any other suitable riparian habitat (e.g. reedbed).

16.4.2 Where the above desk based exercise or the results of other surveys (e.g. Phase 1 habitat survey) identify the potential for, or signs indicating the presence of water vole, a specific walkover survey will be conducted in order to appraise the potential suitability of the habitat present for water vole in more detail, and determine the scope of detailed survey. The habitat assessment should be based on consideration of the following factors:

- bank profile, channel profile and characteristics, and water levels;
- availability of food sources;
- vegetation structure (in particular the extent of suitable marginal vegetation);
- level of shading;
- disturbance levels;
- bordering land use; and
- connectivity with other areas of suitable or sub-optimal habitat.

16.4.3 Based on the above factors and any others which the surveyor considers to be important in the local context, habitat areas requiring detailed survey are to be determined, as well as areas that can be discounted from further investigation.

16.5 Survey method

16.5.1 At each site selected, a detailed water vole survey should take place following the survey guidelines set out in the Water Vole Mitigation Handbook.

16.5.2 Survey extent has been reduced to the land required and a 300m extent upstream and downstream (where access allowed). The reduction in scope followed correspondence with Natural England and a commitment that the undertaker will ensure that all culverts of suitable watercourses will maintain safe passage.

16.5.3 Each survey area should be split into 50m-100m lengths with the start and end of each stretch marked on a map and the GPS coordinate recorded for the beginning and the end of the length. The lengths/areas surveyed are to be mapped and all signs of water vole plotted accurately on a plan with a GPS coordinate taken.

16.5.4 Wherever possible, the survey should be undertaken from within the watercourses, in order to allow for a close search for signs of water vole. Consultants undertaking survey should consider carrying out surveys from a boat in places where water is deep and the margins cannot be safely surveyed from the bank.

16.5.5 During each survey visit the banks of each watercourse/water body (up to a distance of 2m from the edge of the water) should be inspected for signs of use by water vole including the following:

- presence of latrines;
- presence of burrows (both active and inactive);
- presence of runs;
- presence of footprints;
- presence of feeding remains;
- individual droppings; and
- sightings and/or sounds (characteristic sound entering the water) of individuals.

16.5.6 As well as marking all signs on a map, a note should be made of the number of each type of sign recorded so that abundance can be estimated.

16.5.7 The above information will be recorded alongside similar information indicating use by other species (e.g. bank vole, field vole, mink, otter and brown rat). The location of all positive evidence of the presence of both water vole and any other species identified during the survey should be recorded by GPS (to an accuracy of <5m where terrain/vegetation allows).

16.5.8 For each watercourse/water body subject to survey the following additional information should be collected during the first survey visit:

- habitat types present;
- predominant bank substrate;
- adjoining land use;
- vegetation types present and indication of abundance of each using DAFOR scale;
- disturbance at the site;
- bank profile;
- depth;
- width;
- rate of flow;
- signs of recent habitat damage; and
- sketch map of the site.

16.5.9 During each subsequent visit this information should be reviewed and any significant changes since the last survey visit recorded.

16.5.10 Where there is any uncertainty over water vole droppings found that cannot be definitively identified in the field, a small sample (considered to represent droppings from a single species) should be collected and sealed in a plastic bag marked with the following details:

- date sample collected (day/month/year);
- survey location;

- GPS coordinates;
- suspected species; and
- surveyor name.

16.5.11 The sample should be stored in a cool, dry place until the completion of the survey in that area. DNA analysis will subsequently be conducted if considered appropriate, that is, on those dropping samples where the survey has found no other definitive evidence of the presence of water vole within the respective survey area in order to help determine presence/absence.

16.5.12 Once field sign data have been obtained, the population size of the voles in that stretch of watercourse should be calculated. This should be based on the standard recognised method for calculating the population size, namely Morris et al[69].

16.6 Survey programme and effort

16.6.1 Surveys should ideally be undertaken between mid-April and September with at least two survey visits to each water body/watercourse undertaken, in one season. Where access consents allow, a survey should be undertaken in the early season (mid-April to June) and another in late season (July to September). Where constraints prevent this timing, attempts should be made to ensure that visits are conducted at least two months apart.

16.6.2 At sites where no visits are achieved during the period mid-April to September, late visits can be undertaken in October, though an additional spring visit should be undertaken in these situations.

16.6.3 Survey should not be conducted during or following periods of heavy rainfall, as field signs will have been washed away. In general, where possible survey visits should be timed to avoid survey when water levels are high, or when management works have recently taken place.

[69] Morris, P., Morris, M., MacPhearson, D., Jefferies, D., Strachan, R., and Woodroff, G. (1998), *Estimating numbers of water voles Arvicola terrestris: a correction to the published method*. Journal of Zoology, 246, 61-62.

17 Badger

17.1 Introduction and guidelines

17.1.1 Potential impacts on badgers (Meles meles) are likely to be loss of setts within the land required for the construction of the Proposed Scheme, potential for disturbance of setts in close proximity to the land required, and severance/fragmentation of territories.

17.1.2 Survey for badgers will need to identify both sett locations and, where there is the potential for significant severance/fragmentation of territories, an understanding of territory use through detailed survey, including use of bait marking studies if necessary.

17.1.3 Sett surveys are to be conducted in line with guidance provided in Harris et al. (1989)[70].

17.2 Qualifications and experience

17.2.1 All personnel involved in scoping and defining the survey area should be competent in assessing habitat potential for badgers, and the potential impacts of severance/fragmentation of territories.

17.2.2 All personnel conducting detailed badger survey should be competent in the identification of the full range of badger field signs including setts, latrines, hairs, badger paths and foraging signs including 'snuffle' holes. In addition, they should be competent in identifying field signs of other species, such as foxes, rabbits, otters, dogs and cats.

17.2.3 All personnel conducting badger survey should be familiar with the definitions of sett type detailed by Harris et al. (1989), and the classification of setts utilising this methodology in the field. They should have reached the standard required by the CIEEM competence framework[71].

17.2.4 All bait marking surveys should be coordinated by ecologists with experience of utilising this technique.

17.3 Licensing requirements

17.3.1 Proposed survey methodologies will not involve either the destruction or disturbance of setts, so that no licence is required. If it is necessary to monitor activity at setts, camera traps at sett entrances should be used. Application for a licence to interfere with a badger sett

[70] Harris, S., Cresswell, P., and Jefferies, D. (1989), *Surveying Badgers*. Occasional publication of the Mammals Society.

[71] Chartered Institute of Ecology and Environmental Management (2013), *Competencies for Species Surveys: Badger*, CIEEM, Winchester.

(under the Protection of Badgers Act, 1992)[72] would only be required if there is a need for the use of more intrusive methods such as internal camera investigations of setts.

17.4 Screening for survey and defining the survey area

17.4.1 Utilising results from the Phase 1 habitat survey, desk study records and analysis of aerial photographs, consultants undertaking survey work will identify areas within the land required for the construction of the Proposed Scheme, or within a 100m surrounding buffer that are likely to be used by badgers and where there is the potential for significant effects to occur. This assessment should take into account the following criteria:

- suitability of habitat and topography for creation of setts;
- availability of other habitat suitable for badger within close proximity to the land required for the construction of the Proposed Scheme;
- connectivity with other areas of suitable habitat; and
- potential for severance/fragmentation of territories.

17.4.2 Areas selected based on the above criteria will be subject to a detailed survey for field signs.

17.4.3 Where main or annexe setts are identified within the initial survey area, there is likely to be a need to conduct further survey to establish the likely extent of territories. Such decisions on an acceptable extent of further survey should be determined by an experienced badger surveyor.

17.5 Survey methods

Detailed survey for field signs

17.5.1 For all areas subject to survey, a systematic walkover will be conducted of all suitable habitats to obtain records of the following:

- setts;
- hairs;
- badger paths/runs;
- mammal paths (possible badger);
- foraging signs;
- latrines;
- footprints;
- bedding material; and

[72] *Protection of Badgers Act 1992.* Chapter 51. Her Majesty's Stationery Office, London.

- evidence of rabbit and fox.

17.5.2 For all setts identified during the walkover survey, entrances and the orientation of entrance holes should be mapped. The sett should be classified against the criteria laid out in Harris et al (1989) as either a 'main', 'annexe', 'subsidiary' or 'outlying' sett. The level of use for each entrance should be classified as either 'active', 'partially active' or 'disused'.

17.5.3 During the walkover surveyors should also record the location and current use of any large entrances not currently utilised by badger, in order that these entrances can be monitored for future use during the period up to construction.

17.5.4 All field signs of badger, along with those of any other notable species are to be recorded with GPS-derived grid coordinates accurate to less than 5m. Where topography and vegetation structure may have reduced the accuracy of records below this level this information should be noted.

Territory analysis

17.5.5 Following completion of the detailed survey for field signs, results should be reviewed to identify those locations where further survey will be required in order to determine the extent of territories and thus the significance of any effects of the Proposed Scheme on the badger population. Where possible these surveys should be undertaken in the year prior to construction because badger territories change from year to year. They are not required to inform the EIA.

17.5.6 The requirement for detailed survey for field signs over an extended area (i.e. beyond a 100m buffer from the land required from the construction of the Proposed Scheme) should be considered at all locations where detailed survey for field signs identifies a main or annexe sett within the land required for the construction of the Proposed Scheme or within a 100m buffer of the land required.

17.5.7 The aim of such further surveys would be to better understand those territories that may be subject to significant effects as a consequence of the construction of the Proposed Scheme, either through loss or disturbance of setts, loss of foraging habitat, or severance of commuting routes. It is envisaged that in the first instance this would involve extending the survey extent in the vicinity of identified main setts to determine likely territory boundaries, principally through the identification and mapping of boundary latrines. The extent of survey appropriate at each location is likely to vary and should be determined and justified by a competent badger surveyor.

Bait marking

17.5.8 It is likely that in some locations following survey of an extended area for field signs, it will be necessary to conduct bait marking exercises to aid in the identification of territory boundaries. Active main setts and annexes within the survey area that could be significantly affected should be selected for bait-marking studies, with each main sett being designated

with a uniquely coloured plastic marker; other setts are to be included as required. On the first two days of feeding, bait should be deposited down any active holes; after this period, bait should be distributed up to a distance of 15 – 20m from active holes.

17.5.9 Once the survey is completed, the location of each latrine and the origin of the coloured return are to be charted on a map.

17.6 Survey programme and effort

Survey for field signs

17.6.1 Detailed survey for field signs is to be conducted during early spring or autumn/winter, where possible.

Bait marking

17.6.2 Bait-marking should generally be conducted during late February, March and April when territorial activity is typically at its peak.

17.6.3 Active sett entrances to be baited should be visited daily preferably in the late afternoon. Approximately 25 – 30 bait points should be applied for each main sett.

17.6.4 Bait should be laid daily for approximately two weeks. Approximately one week after commencements of baiting, daily checks should commence to identify any latrines containing bait. Latrine checks should continue for approximately seven days after the cessation of baiting. Marked droppings may contain low numbers of beads; therefore each latrine/dropping should be inspected thoroughly using a pallet knife or trowel.

18 Polecat

18.1 Introduction and guidelines

18.1.1 Polecats (Mustela putorius) are protected (in part) in the UK under the Wildlife and Countryside Act, 1981 (as amended), and classified as a Priority Species in the UK Biodiversity Action Plan[73], as well as a Species of Principal Importance under the NERC Act[74].

18.2 Qualifications and experience

18.2.1 Surveyors must have the skills and experience enabling them to:

- assess habitat potential for polecats;
- identify field signs, including footprints and the variation in morphology of small carnivore scats; and
- identify polecats, especially the distinguishing features between polecats and polecat-ferrets

18.3 Licensing requirements

18.3.1 A licence is not required for surveys involving the recording of field signs (including the use of camera traps). A licence is required if polecats are to be trapped or taken. The methods outlined below are all non-licensable.

Screening for survey and defining the survey area

18.3.2 Polecats are habitat generalists that set up home in lowland woodlands, marshes, along riverbanks or even in farm buildings or dry stone walls. In England, networks of farmland with hedgerows and small woods are preferred. Polecats are commonly associated with rabbit burrows/warrens and are often attracted to road kill/carrion (hence the high levels of road casualties in polecats). For these reasons it is difficult to target detailed surveys for polecats for any particular habitat, and the following approach has therefore been developed.

18.3.3 The following sets out the methods to be used in attempting to record occurrences of polecat along the route of the Proposed Scheme.

[73] Joint Nature Conservation Committee (1994), *UK Biodiversity Action Plan.*

[74] *Natural Environment and Rural Communities Act* 2006. (Chapter 26). Her Majesty's Stationery Office, London.

Survey methods

18.3.4 Road casualties and live sightings are by far the most effective means of detecting the species (in the 2014/15 national survey (co-ordinated by the Vincent Wildlife Trust[75]), 50% of records received were road casualties, 36% were live sightings). Most live sightings are of polecat crossing roads or of polecats in gardens (e.g. where denning in outbuildings, beneath sheds or decking). The survey protocol outlined in the following paragraphs, developed from guidance in the Mammal Society guidance[76], should be followed.

18.3.5 Every effort should be made by surveyors to look for and record the species when in areas of suitable habitat, as part of other ecological surveys carried out. Furthermore, surveyors should actively look for signs of the presence of the species, focusing on potential den sites and field signs in association with these sites, such as footprints and scats. Polecats typically den in rabbit burrows, log piles, hay stacks and farm buildings and there are often piles of scats adjacent to den sites as well as tracks and prints.

18.3.6 In order to align with recent survey protocols for the species, surveyors must provide a six-figure grid reference location for each sighting (live or dead), along with photographs where applicable (especially for road casualties). Photographs must also be taken of any other potential field signs that may aid identification, such as prints and scats, and scats should be collected for subsequent DNA analysis, with clear labelling of location and date of collection.

18.3.7 Where supported by a sighting/visual evidence, animals should be classified into a phenotype category on the basis of pelage characteristics (true polecat, polecat-ferret or ferret (encompassing feral and domestic ferrets)).

18.3.8 Camera traps should also be considered by exception in the following scenarios, but only where it is considered likely that cameras may realistically assist in detection (such as along linear features likely to be regularly followed by animals):

- where recent confirmed sightings have occurred (e.g. reported presence by landowners); and/or
- where evidence is found that is considered to be strongly indicative of presence (e.g. piles of scat outside of rabbit burrows, footprints suggestive of the species).

18.3.9 If cameras are deployed, they must be left in situ for a period of several nights, on two or more occasions within the appropriate season (see survey programme and effort). To further increase the likelihood of success, consideration should be given to leaving bait in the field of view of the camera, such as eggs or peanut butter.

[75] Croose, E. (2016), The Distribution and Status of the Polecat (*Mustela putorius*) in Britain 2014 - 2015. The Vincent Wildlife Trust.

[76] Cresswell, W.J., Birks, J.D.S., Dean, M., Pacheco, M, Trewhala, W.J., Wells, D & Wray, S. (2012), *UK BAP Mammals - Interim Guidance for Survey Methodologies, Impact Assessment and Mitigation*. The Mammal Society.

18.3.10 Consideration will be given to live-trapping at certain sites, but only where absolutely necessary to verify unconfirmed records. Further guidance will be added (here or separately) if this methodology is to be implemented at any site.

Survey programme and effort

18.3.11 Information on casualties and live sightings can be provided at any time of the year, as part of recording for other target habitats and species.

18.3.12 Camera traps, where deployed, are most likely to achieve results in the late summer period, when the young have dispersed and the number of active individuals is at its peak. It is therefore recommended that traps be set between the months of July and September, though May, June and October could be considered sub-optimal alternatives, where access between July and September may not be possible.

19 Invertebrates

19.1 Introduction and guidelines

19.1.1 The invertebrate surveys to be conducted are aimed at identifying significant effects on invertebrates as a result of the construction of the Proposed Scheme. Therefore, survey design and analysis should be directed towards the aim of providing sufficient information to allow an assessment of significant effects on invertebrate species and assemblages to be made. Most of the methods described are derived from 'Surveying terrestrial and freshwater invertebrates for conservation evaluation' (Natural England, NERR005 2007)[77], but focussed upon the need to support an ES.

19.1.2 Many invertebrate taxa are poorly understood in terms of their ecology and distribution. Although records of the presence of such species are a valuable addition to distributional knowledge, it is often not possible to accurately assess the value of a species record in a taxon which does not have a good database of distributional information. Even the first record of a species in a poorly known group does not necessarily confer significance to the site from which it was recorded without suitable contextual information. To avoid unnecessary and/or unhelpful records, the best solution is to use the recommended taxa for each habitat in the NERR005 document.

19.2 Qualifications and experience

19.2.1 Field surveyors should ideally be competent entomologists but where sample collection is made for later identification, the surveyors are to be trained and/or have extensive experience in the techniques which are to be employed, including the collection, preservation and labelling of specimens. Identification should only be undertaken by competent taxonomists. There is currently no formal competency framework and so fulfilment of at least one of the following is required:

- member/Fellow of the Royal Entomological Society;
- employed as an entomologist by a museum/local authority/conservation organisation;
- working as a professional consultant entomologist with track record in the groups under consideration; or
- having a substantial record of publications relevant to the species groups that are being surveyed.

[77] Drake, C.M., Lott, D.A., Alexander, K.N.A. and Webb, J. (2007), *Surveying Terrestrial and Freshwater Invertebrates for Conservation Evaluation*, Natural England, Sheffield.

19.3 Licensing requirements

19.3.1 All surveys should follow the guidelines provided by the Joint Committee for Conservation of British Insects (2002)[78].

19.3.2 The following legal constraints are based on Natural England research report NERR005 (2007) and should be considered when conducting surveys:

- legally protected invertebrates (see the JNCC website): a license issued by the relevant statutory conservation agency is needed to collect species fully protected under the Wildlife and Countryside Act. This will also cover invertebrates listed in Annex IV of the Habitats and Species Directive and for which a license is required under European regulations;
- legally protected vertebrates: it is an offence to collect or disturb protected species even as an incidental part of a lawful operation. A licence is needed if there is risk of capturing protected species (such as great crested newt) in pitfall and other passive open traps. A wire mesh placed over pitfall and water traps will reduce or prevent this risk, but may also reduce the catch of larger invertebrates;
- bye-laws and rules: capturing animals is prohibited by bye-laws and the rules of several organisations, including the Forestry Commission, Forest Enterprise, the National Trust, the Environment Agency, county wildlife trusts and local authorities (for Nature Reserves). Permission is required for surveys on sites covered by such bye-laws and rules;
- National Nature Reserves and Sites of Special Scientific Interest: collecting on these sites is classed in England as an 'operation likely to damage'. Permission to collect must be obtained from the local office of the statutory conservation agency. Permission is unlikely to be refused for a 'bona fide' survey; and
- criminal damage: under the Wildlife and Countryside Act, it is an offence to uproot a wild plant without the landowner's permission. If surveys require activities such as digging up plants or splitting branches, it is advisable to inform the landowner in advance.

19.4 Screening for survey and defining the survey area

19.4.1 The requirement for invertebrate surveys will be based on the results of the desk study, habitats identified by the Phase 1 habitat survey and their location, and are likely to be focused at survey within the land required for the construction of the Proposed Scheme and a 100m buffer either side of this.

[78] Joint Committee for Conservation of British Insects (2002), A Code of Conduct for Collecting Insects and other Invertebrates. British Journal of Entomology and Natural History. 15 (1), 1-6.

19.4.2 A survey should be considered if the desk study provides records of protected species, species of principal importance, UK Biodiversity Action Plan species, Red Data Book species, or nationally scarce invertebrates within 2km of the route and the habitats present within the land required for the construction of the Proposed Scheme and surrounding 100m buffer either side of it are capable of:

- providing suitable breeding areas; or
- hold a significant resource for maintenance of at least one part of their life cycle (e.g. foraging habitat or overwintering habitat for eggs/larvae).

19.4.3 Additionally, if the Phase 1 habitat survey identifies potentially significant habitats for invertebrates (e.g. marshy grassland, species-rich grassland, diverse woodland/scrub), then these habitats should be subject to a specific habitat assessment for invertebrate interest and the findings of this assessment used to determine whether specific sampling surveys are required.

19.4.4 Aquatic invertebrate surveys will be targeted to watercourses and water bodies with records of significant species (as defined in paragraph 19.4.2) occurring anywhere in the watercourse/catchment which have similar habitat requirements as those present within the land required for the construction of the Proposed Scheme or the 100m buffer surrounding it. In respect of watercourses, additional data from the Environment Agency should be sought. In cases where an assemblage of aquatic macro-invertebrates of high ecological value (as evidenced by an above average BMWP score occurring on a regular basis within a timescale of the last 5-10 years) occurs within the same catchment/tributary as the study site, then aquatic invertebrate surveys should be undertaken.

19.4.5 It is recognised that survey areas for invertebrates will vary greatly, dependent upon the habitats considered to be of importance, and the species under consideration, for example a small area of river shingle for certain beetle species or a series of marshy grasslands for marsh fritillary metapopulation assessments. Decisions on survey area should be made by the entomologists conducting the survey, but the key focus of any survey work should be within the land required for the construction of the Proposed Scheme and a 100m buffer either side of it. Outside this zone, consultants undertaking survey works should submit a deviation request to HS2 Ltd where they feel there is the requirement for additional survey to identify potential significant effects.

19.5 Survey methods

19.5.1 Species information from each site should be in a format suitable for input to Pantheon database[79]. This is a computer application developed by Natural England. Pantheon database interprets species lists by recognising assemblage types within a list and scoring

[79] Webb, J., Heaver, D., Lott, D., Dean, H.J., van Breda, J., Curson, J., Harvey, M.C., Gurney, M., Roy, D.B., van Breda, A., Drake, M., Alexander, K.N.A. and Foster, G. (2018), Pantheon - database version 3.7.6. Available online at: http://www.brc.ac.uk/pantheon/.

each type according to its conservation value. It provides a standardised, and accepted, method of evaluation across the Proposed Scheme. Further details on these data requirements are presented in Natural England (2007).

19.5.2 Pantheon will be a useful tool in assessing whether an invertebrate sample across several taxonomic groups is representative of these aquatic habitats.

19.5.3 To ensure appropriate biosecurity measures, surveys are to follow the guidelines for Check, Clean, Dry from the Non Native Species Sectretariat website[80].

Terrestrial habitat survey

19.5.4 Where it is assessed that detailed surveys are required, then the appropriate methods relevant to the taxa and habitats under consideration are to be adopted. These methods could include but are not necessarily limited to:

- sweep netting - standardised through timed netting in appropriate habitats, if required;
- hand searches of specific host plants (for leaf mines, galls) of particular species;
- egg searches (e.g. black hairstreak);
- conspicuous aggregations (e.g. marsh fritillary 'webs');
- pitfall trapping;
- white tray trapping;
- suction sampling;
- light trapping; and
- visual searches/ transects for some groups such as (but not limited to) *Lepidoptera* (most butterflies) and *hymenoptera* (bumblebees and some other readily identifiable species).

19.5.5 Methods selected are to be as species specific and/or focussed as possible on habitats of actual or potential importance. Natural England (2007) provides details of standard methodologies, and the selection of appropriate methods in terms of habitats and taxa. The methods adopted should follow this guidance wherever possible. Methods such as light trapping, which attract specimens from a large distance, should be used with caution.

19.5.6 In addition, general butterfly surveys will be required in identified suitable habitats and include brownfield sites in urban areas where species such as grizzled and/or dingy skipper are known or suspected.

19.5.7 Generally, the surveys for butterflies are to be based upon the establishment of transect walks that are surveyed a minimum of three times (May, June, July) recording species at an appropriate time (10.00-16.00) and during suitable weather conditions (temperatures not

[80] GB Non-native species secretariat. Check, clean, dry. Available online at: http://www.nonnativespecies.org/checkcleandry/.

below 13°C and 13-17°C only if at least 60% sunshine; clear or light cloud; still or light wind (less than Beaufort Scale 5); no rain).

Aquatic invertebrates

19.5.8 Rivers and streams are to be sampled according to the published methodology applicable to the size of the watercourse (e.g. 3-minute kick sampling, surber sampling) and specimens identified to species level or the lowest possible taxonomic unit and counted. Measurements of the environmental variables required for input into RIVPACS are also to be taken and then the data set(s) analysed using the RIVPACS program, if this is considered necessary to predict likely significant effects.

19.5.9 Surveys of ditches selected (see Section 8) are to follow the published methodology in 'A Manual for the Survey and Evaluation of the Aquatic Plant and Invertebrate Assemblages of Grazing Marsh Ditch Systems' Version 6 May 2013 Buglife – The Invertebrate Conservation Trust[81].

19.5.10 It is acknowledged that the above methodologies were devised for use in a programme of survey and evaluation work relating to the ditches associated with grazing marshes. However, the general survey strategy is considered to remain valid and the evaluation procedures outlined within the manual will be modified so that they are appropriate. A modified version of the evaluation criteria appropriate to the ditch types surveyed are to be utilised.

19.5.11 Surveys of ponds (see Section 9 for selection process) are to follow one of the methods approved by the Freshwater Habitats Trust as part of the National Pond Monitoring Network[82]:

- the rapid assessment for ponds requires invertebrate sampling only and is a rapid assessment of 'naturalness' using invertebrate diversity and families similar to the Biological Monitoring Working Party system for running water;
- the Predictive SYstem for Multimetrics (PSYM) method includes collection of physical data, invertebrate sampling and plant recording. These data are used to undertake an analysis to compare the pond against a national database held by the Freshwater Habitats Trust (formally the Pond Conservation Trust). The data are submitted to the Freshwater Habitats Trust for analysis; and
- The National Pond Survey method provides a more detailed assessment of a pond and includes environmental and chemical data from the pond in addition to plant and invertebrate survey and ideally requires sampling of the invertebrate fauna over three seasons.

[81] Palmer, M., Drake, M., Stewart, N. (2013). *A manual for the survey and evaluation of the aquatic plant and invertebrate assemblages of grazing marsh ditch systems*. Version 6. Buglife.

[82] Freshwater Habitats Trust (2013), *Pond conservation*. Available online at https://freshwaterhabitats.org.uk/.

19.5.12 The method used will depend on the location of the pond (e.g. within the land required for the construction of the Proposed Scheme, or outside of it) and the potential impact upon it.

19.6 Survey programme and effort

19.6.1 The number and timing of visits will be dependent on the habitats to be surveyed, and the taxa under consideration. The guidance and advice presented in the Natural England research report NERR005 (2007) should be used on a case by case basis. Typically, where surveys are required, three sample sessions spaced out between May and September are likely to be appropriate for terrestrial habitats; two visits (spring and autumn) for aquatic habitats.

20 White-clawed crayfish

20.1 Introduction and guidelines

20.1.1 Where white-clawed crayfish (*Austropotamobius pallipes*) may be present and significant effects could occur, then survey is likely to be required. The scope of survey required is defined in Peay (2004)[83] and is set out below.

20.2 Qualifications and experience

20.2.1 The competency standards for white-clawed crayfish have been issued by CIEEM[84] and at least one surveyor should meet or exceed those minimum standards and have held and used a survey licence for white-clawed crayfish survey for at least one year. The licence holder will ensure that any assistants have had sufficient training in biosecurity, crayfish habitat appraisal and survey practice to carry out work properly and that they are supervised as appropriate.

20.3 Licensing requirements

20.3.1 The ecologist responsible for the crayfish surveys must hold a protected species survey licence from Natural England for surveys at locations with the potential for white-clawed crayfish. In addition, consent for trapping and manual searching will be required from the Environment Agency Fish Movement Team at Brampton.

20.4 Screening for survey and defining the survey area

20.4.1 The relevant scale for distribution data on white-clawed crayfish is the sub-catchment. Most data are held by the Environment Agency in the Area offices. Desk studies should search for records for white-clawed crayfish, signal crayfish and other non-native crayfish species. The best composite database was compiled for a Defra project and includes a classification of sub-catchments (Rogers and Watson, 2011)[85].

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[83] Peay, S. (2004), *A cost-led evaluation of survey methods and monitoring for white-clawed crayfish – lesson from the UK*. Bulletin Français de la Pêche et de la Pisciculture 372-373, 335-352. Available online at: https://cdn.buglife.org.uk/2019/07/Crayfish-Ecology-Survey-resources.pdf (hosted by Buglife).

[84] Chartered Institute of Ecology and Environmental Management (2013), *Competencies for Species Surveys: White-clawed Crayfish*. CIEEM, Winchester.

[85] Rogers, D. and Watson, E. (2011), *Distribution database for crayfish in England and Wales*. In: Rees M, Nightingale J, Holdich (eds) Species survival: securing white-clawed crayfish in a changing environment. Proceedings of a conference held on 16 and 17th November 2010 in Bristol, UK. Available online at: https://cdn.buglife.org.uk/2019/07/Crayfish-Ecology-Survey-resources.pdf (hosted by Buglife).

20.4.2 Surveys for white-clawed crayfish can be screened out when any of the following apply:

- best available information indicates there are no white-clawed crayfish remaining in the sub-catchment (although allowance should be made for the possibility of small relict populations in headwater streams if the species has been lost from the main river, if there have not been any recent surveys to check status);
- the watercourse within the land required for the construction of the Proposed Scheme and adjoining 100m buffer either side is dry during any period of the year;
- there are confirmed records of non-native crayfish within 1km of the land required for the construction of the Proposed Scheme as measured along a watercourse (note this can include records of non-native crayfish in angling ponds and fish farms where there is an inflow or outflow that offers a potential route for escape, i.e. from almost all sites with non-native crayfish) and other surveys indicate that there have been no white-clawed crayfish present within the past five years in the study area;
- there are records of non-native crayfish up to 5 km from the land required for construction of the Proposed Scheme, both upstream and downstream on the same watercourse and there are grounds to expect that there is a continuous population of non-native crayfish between them. Any tributary of a known invaded watercourse should be surveyed unless there are grounds to expect the tributary has been invaded as far as the land required for the construction of the Proposed Scheme and beyond it for a period of five years or more;
- water quality is poor (GQA D or less, or Water Framework Directive (WFD) equivalent) currently;
- water quality has been poor (GQA D or less, or WFD equivalent) within the past 10 years and there are no populations of white-clawed crayfish in connected tributaries within 2km;
- water chemistry is unsuitable due to mean pH6.5 or less and/or calcium less than 5mgl-1;
- extended Phase 1 habitat survey and/or River Corridor Survey shows that there is no potentially suitable habitat for white-clawed crayfish (e.g. channel is a highly modified open culvert with walls of mortared stone, intact brick or sheet piling, and a channel bed which also has no refuge potential for crayfish; note however that banks of unmortared stone revetment and damaged brick or concrete can be very favourable habitat, even if there is only small substrate such as sand or gravel);
- there has been an incident of crayfish plague within the past five years and there is no known or potential surviving relict population in the watercourse or connected tributaries within 2km; and/or
- specific surveys for crayfish have been carried out within the past three years in the watercourse at more than one site, at least one of which is within 2km of the land required for the construction of the Proposed Scheme, and no crayfish have been found.

20.4.3 The requirement to survey static water bodies such as farm ponds, quarries and other wholly enclosed still water sites should be considered, taking into account the location, permanence, water quality, the degree of isolation from other water bodies, and desk study

data for white-clawed and non-native crayfish species in the local area. Where such water bodies are considered potentially suitable to support white-clawed crayfish (including where sites may have been suitable to be utilised as an Ark site[86]) and full survey is considered to be required the consultant undertaking surveys should submit a deviation request to HS2 Ltd. For all static water bodies scoped out a rationale for this decision should be recorded making reference to the criteria listed above.

20.4.4 Records of white-clawed crayfish within the past ten years will provide information on potential presence in water bodies, but even populations surveyed within the past two years are not necessarily still present. By contrast, all validated records of signal crayfish or other non-native crayfish should be assumed to be still present and more extensive than they were when last recorded.

20.4.5 Watercourses or other water bodies that lie within the land required for the construction of the Proposed Scheme and surrounding 100m buffer either side of it and have not been screened out (as described above) should be surveyed if there is potential for significant effects. Where habitat suitable for survey is limited within this zone, but there is potentially favourable habitat beyond, the survey area should be extended out, up to a 250m buffer from the land required for the construction of the Proposed Scheme. Depending upon predicted impacts, there may be a need to survey more than one site on the watercourse. Selection of reaches to survey should use the approach in Peay (2003)[87].

20.4.6 If there are difficulties in obtaining permission to survey some areas, the location of the survey site can be shifted upstream or downstream in a reach; provided at least part of the site is within 500m of the land required for the construction of the Proposed Scheme and there are no differences in water quality, the habitat is similar and there are no barriers that might affect the distribution of crayfish (e.g. a weir might have been enough to stop an outbreak of crayfish plague infecting the population upstream).

20.5 Survey methods

20.5.1 The survey method(s) used are to be the most appropriate for the type of habitat present (see Peay, 2004). The potential habitat for crayfish and the scope for using different survey methods should ideally be assessed in advance, e.g. as part of extended Phase 1 habitat survey.

20.5.2 Survey sites will be a minimum of 100m long (where there is abundant manually searchable habitat of good quality); generally up to 200m for most small watercourses; or up to a maximum of 400m where suitable areas for survey are localised or widely dispersed, e.g. in large watercourses.

[86] One approach to conserving the white-clawed crayfish is to establish isolated new refuge sites, known as 'Ark sites', where new populations can be established, safe from non-native crayfish and crayfish plague.

[87] Peay, S. (2003), *Monitoring the White-Clawed Crayfish Austropotamobius pallipes*. Conserving Natura 2000 Rivers. Monitoring Series No. 1. English Nature, Peterborough.

20.5.3 A site-scale habitat appraisal for crayfish is to be carried out. This includes a description plus site photographs, but in addition, any water body surveyed within the land required for the construction of the Proposed Scheme should be mapped in the style of a River Corridor Survey with annotation of features relevant to crayfish habitat quality, e.g. pool under bridge with many cobble-sized stones and cracked mortar below water; alder trees with dense swags of submerged roots or sewage fungus downstream of pipe discharge along right bank.

20.5.4 Particular attention is to be given to whether conditions will be suitable for manual survey, i.e. there must be ample loose, 'searchable' potential refuges in shallow water less than 0.5m deep in water that is clear, with little settled silt and with extensive lengths (greater than 100m) that can be safely accessed from the bank and waded. Where these conditions are not met, some searching of debris and undercut banks by kicking and netting is to be undertaken where possible. If netting is not feasible, or does not yield crayfish, then trapping is required. If crayfish are identified by manual survey or netting, or by other signs of crayfish, e.g. exuvia, claws etc., it is not necessary to carry out trapping as well.

20.5.5 All crayfish surveys are to be carried out in dry weather and normal to low flow. If there is any rainfall overnight during a trapping survey the survey is invalid if rain falls within four hours of sunset.

20.5.6 Biosecurity measures are to be implemented throughout, with disinfection (iodine based disinfectant) of all equipment between water bodies (Follow the guidelines for survey bio-security as set out by Check, Clean, Dry guidance from the Non Native Species Sectretariat website[88]Where more than one site is surveyed on a watercourse, surveys will be carried out at upstream sites first. If a downstream site is surveyed first, there will be disinfection between sites. As far as practicable, traps are to be placed where they are least likely to be seen or tampered with, to minimize the risk of losses or subsequent use for illegal trapping. Signal crayfish should not be released back to the wild, and a suitable method of despatch should be used as determined from Environment Agency guidance.

20.5.7 Where the desk study suggests there is a relatively abundant population of crayfish and plenty of stony habitat to search, a standardised manual survey of five habitat patches of ten good refuges gives a high probability of detecting crayfish. However, where populations are at low abundance and conditions are sub-optimal for manual search, the chances of detecting a crayfish with this level of effort are less. Furthermore, as the method described in Peay (2003) includes searching cobbles and pebbles under large cobble and boulder as one refuge, the actual number of stones searched in a standardised survey may be 2-3 times higher. Where status of crayfish is unknown, survey effort is to be double the minimum, preferably with more patches searched rather than just more refuges in one area.

[88] GB Non-native species secretariat. *Check, clean, dry*. Available online at: http://www.nonnativespecies.org/checkcleandry/.

20.5.8 Trapping surveys are to target the areas with the highest potential for crayfish, avoiding any areas with fast flow or anoxic silt. Traps need not be wholly immersed, but trap apertures must be entirely below water level throughout the trapping session. Traps should be sited to avoid overlap of trapping zone. Traps will be left for one night only and will be lifted the next morning. Trap mesh size should ideally be less than 22mm.

20.5.9 One or more digital photographs are to be taken to confirm the species of crayfish recorded. Photographs should be taken such that the diagnostic features are clearly visible. If there is any doubt about identification, reference specimens should be taken and preserved. This may be necessary with juvenile crayfish especially with the less common non-native species, such as Orconectes virilis cf O. limosus. Preservation uses 90% ethanol solution, preferably with 10% formalin to fix (suitable COSHH and risk assessment will be required for using the preservative). Alcohol will need to be changed/topped up, especially if large specimens are preserved.

20.5.10 Where signal crayfish are recorded during a survey then that survey session at the location should be completed in full. However, assuming that no white–clawed crayfish are found then no repeat survey sessions should be conducted at that site. If there are other sites to be surveyed in the same watercourse, they should still be surveyed if records or other information suggests that it is likely white-clawed crayfish were present within the past five years. This is to help find any semi-isolated relict populations of white-clawed crayfish.

20.6 Survey programme and effort

20.6.1 All surveys should ideally be carried out in good conditions in the period July to September inclusive. Whilst intensive manual surveys on sites with high densities of crayfish may detect presence at most times of year, nil catches outside the main season of activity are invalid. All surveys conducted outside the July to September period should acknowledge that negative results are not suitable to confirm absence.

20.6.2 Manual survey effort should be doubled where conditions are suitable and crayfish are not detected in the first session. Where there is enough suitable habitat but manual survey is not practical and there is potentially good habitat in the banks, a trapping session should be added.

20.6.3 At sites where trapping is carried out, a survey will use a minimum of 20 traps per site in favourable habitat. If crayfish are not detected, a second session should be carried out at least one week after first session (provided it is within the survey season).

20.6.4 Stages of work on site are as follows:

- walkover of the survey site for prior assessment of potential for crayfish habitat at site scale and safety check;
- carry out manual survey if suitable habitat is available and suitable for survey;
- complete five patch standardised survey, with supplement by netting if necessary;

- if crayfish are not found, extend the manual survey extent and coverage to double session;
- if crayfish are not found, or if conditions are not suitable for manual survey, set minimum 20 traps in best habitat;
- if crayfish not found, repeat trapping session after one week or more; and
- if crayfish are not found, conclude that they are likely to be absent.

21 Fish

21.1 Introduction and guidelines

21.1.1 The requirements for fish survey are to be assessed following a review of existing data, and where possible an initial habitat assessment. Following the review of existing data, the consultants responsible for survey work will agree with the local Environment Agency team the most appropriate scope and method of survey on a location by location basis for assessing the potential for significant impacts on fish.

21.2 Qualifications and experience

21.2.1 Surveyors are to be competent in fish habitat assessment and survey.

21.3 Licensing requirements

21.3.1 No licences are required for the initial habitat assessment.

21.3.2 Relevant consents from the Environment Agency are to be obtained prior to commencement of any further fish surveys such as electrofishing.

21.4 Screening for survey and defining the survey area

21.4.1 Requirements for fish surveys are likely to be strongly influenced by the availability and quality of fisheries data from the Environment Agency. Where insufficient data exist to assess likely effects, surveys are more likely to be required for water bodies meeting one or more of the following criteria:

- water bodies designated under the EC Freshwater Fish Directive (2006/44/EC);
- water bodies designated as Special Areas of Conservation (SAC) or Site of Special Scientific Interest (SSSIs) for fish species or their water habitat; and/or
- water bodies likely to host protected fish species/fish species of conservation concern.

21.4.2 Water bodies affected by the route should be categorised for fish habitat quality and the potential for utilisation by fish. Surveys may be necessary for moderate and good habitats that could be directly or indirectly affected by the proposals where no existing recent data are held by the Environment Agency. Further surveys are unlikely to be required for poor habitats.

21.4.3 Typical descriptors for good, moderate and poor quality habitats are as follows:

- good: for running waters the habitats include varying flow types to include rifles pools, runs, and glides. Substrate diversity is more complex and there is good cover to provide

refuge for juvenile and adult fish (both in-stream/body and marginal vegetation). Substrate is present for spawning salmonids. No evidence of pollution or other degradation. No obvious barriers to migration (where applicable to species concerned);

- moderate: for running waters the habitats include a number of flow types throughout the survey reach. Limited substrate diversity. Sparse cover for both juvenile and adult fish. Lower in-stream/body and marginal vegetation diversity. Limited substrate present for spawning salmonids. No evidence of pollution; other degradation (e.g. poaching) may be present. Potential barriers to upstream migration present (where applicable to species concerned); and
- poor: habitats with minimal variation. Substrate diversity limited. No bankside/marginal cover for fish. In-stream and marginal vegetation (where present) typically limited to single dominating species. No substrate available for spawning salmonids. Water body may receive diffuse, land-based pollution (run-off) and exhibit a high degree of other degradation such as poaching. Barriers to upstream migration (debris/man-made dams) present (where applicable to species concerned).

21.4.4 The consultants undertaking survey work should recommend the survey area on a site by site basis depending on habitat quality, upstream and downstream characteristics and likely effects on fish. Where access and seasonal constraints dictate it may be necessary for fish habitat assessments to be undertaken in parallel with detailed survey work.

21.5 Survey method

21.5.1 As most affected water bodies requiring survey are likely to be small the primary method is likely to be electrofishing (utilising stop nets where necessary). This should be undertaken in accordance with British Standard BS EN 14011:2003, BS 6068-5.32:2003 'Water Quality: Sampling of fish with electricity'[89]and 'Guidelines for Electric Fishing Best Practice (Beaumont et al., 2002)[90] published by the Environment Agency. It is likely that a single pass of approximately 100m2 will be sufficient.

21.5.2 If fish survey is necessary and conditions are not suitable for electrofishing then a seine-netting sweep is likely to be employed. Detailed survey methods used will dependent on the watercourse characteristics and will be agreed with the local Environment Agency team.

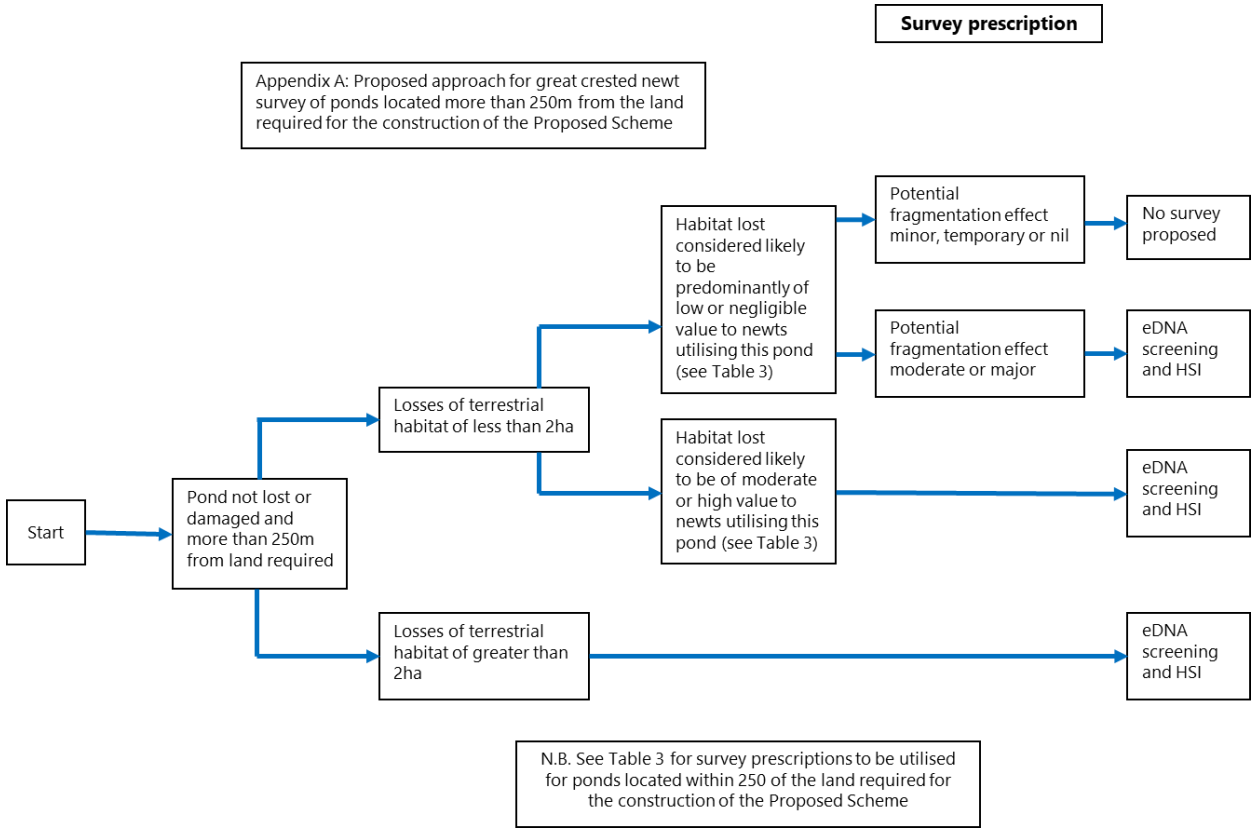
21.6 Survey programme and effort

21.6.1 Survey programme and effort are to be confirmed following discussion with local Environment Agency teams.

[89] British Standards Institution (2003), *EN 14011: 2003 Water Quality Sampling of Fish with Electricity*.

[90] Beaumont, W.R.C., Taylor, A.A.L., Lee, M.J., Welton, J.S. (2002), *Guidelines for Electric Fishing Best Practice. R and D Technical Report W2 – 054/TR*. Environment Agency, Almondsbury.

Appendix A: Great crested newt survey decision flowchart



Appendix B: Use of non-standard survey methods to provide early warning of the presence of great crested newt

Introduction

Where it has not been possible to complete amphibian survey of a water body during the mid-March to mid-June survey window, efforts will be taken to provide early warning of potential presence of great crested newt through late season surveys.

Ecological surveyors should submit their proposals to overseeing consultants for approval where non-standard survey methods can be employed to gain further information prior to the following mid-March to mid-June survey window. It is unlikely that use of non-standard survey methods will be justifiable at all water bodies. Consultants undertaking surveys should consider the likely potential for significant impacts on any populations that are present and/or for significant mitigation requirements, based on the current assumed land required for the construction of the Proposed Scheme.

Survey method

For each pond identified as being suitable for late amphibian survey a single night time visit should be conducted during September to conduct survey utilising the following methods:

- netting for larvae – netting would utilise a 2-4mm long handled dip net and be conducted during day or night. A single perimeter walk would be conducted with at least 15 minutes of netting conducted per 50m of shoreline; and
- torching – a single torchlight survey during September.

Survey may be conducted on any nights where air temperature is 5°C or above at point of survey until the end of September.

It is likely that at some water bodies, the use of one of the above methods may be unsuitable as a consequence of site specific constraints. In all such cases a record should be made of the rationale for excluding a particular method.

Late season survey will only be utilised to provide early warning of potential amphibian constraints, and to identify those areas where further mitigation effort may be required.

Where access is available, all water bodies where standard pond survey was not completed (or commenced) during the current survey season will be subject to full presence/absence or population size class assessment (as appropriate) during the subsequent mid-March to mid-June period.

Appendix C: Screening for survey and defining the survey area

Introduction

Where there are significant restrictions on access, consultants undertaking survey should consider the use of car based transects to provide some baseline information on bat assemblages within these areas. As the methodology will involve driving at slow speed the use of the methodology must be limited to local roads (i.e. excluding motorways, dual carriageways and A roads), and in all cases it will be necessary to submit a detailed risk assessment for the approval of the HS2 Ltd. It will be the responsibility of the consultant undertaking survey works to notify the appropriate authorities (e.g. local Highways Authority and local police[91]) prior to commencing the survey.

Method

All surveys will require a minimum of two surveyors. One of the surveyors will be exclusively driving and have no involvement in the operating of bat survey equipment.

Car transect routes should be planned using aerial photographs and should focus on local roads passing through the land required for the construction of the Proposed Scheme and a 100m buffer either side. Where appropriate features of particular bat interest within 500m of the land required for the construction of the Proposed Scheme were identified during scoping these should also be included. Where possible the transect route should incorporate stopping points (three minutes per stop) in close proximity to the land required and at other features of potential bat interest. A day time drive through of the proposed survey route should always be conducted prior to the first survey visit in order to identify suitable safe stopping points. The risk assessment will be reviewed and updated after the day time drive through.

All car transect surveys should commence at 45 minutes after sunset and continue for at least two hours. The length of each car transect should be planned to ensure that at least two passes of the entire transect route can be completed during each survey visit. In order to maximise recording within close proximity to the land required, the transect route may be not continuous.

Car based surveys should be conducted using a GPS enabled EM3 or SM2BAT+ or similar detector recording in full spectrum mode. The microphone should be held within a car mount or clamp at window level at a 45 degree angle on the passenger's side or, where the

[91] Where appropriate the police should be contacted via non-emergency number to log details of the route and gain an incident number.

microphone can be attached (as for the SM2BAT+) to a cable, it may be securely taped to the vehicle at window level.

Sections of the transect route subject to survey should be driven at a steady speed of 15mph (24km/h) utilising a vehicle mounted with flashing orange double beacon, reflective chevrons and a reflective sign stating 'Surveying'.

Summary of survey programme and effort

Each car based transect route should be subject to a total of two dusk surveys per month during September and October and April, May and June. The starting point and direction of the transect route should be varied between survey visits.

Where habitat quality is high, or the presence of Annex II species is suspected, consideration should be given to the requirement to undertake additional visits each month.

Appendix D: Criteria for potential otter holt locations and determining usage

Description of criteria

The following criteria devised by Paul Chanin (unpublished) should be utilised to identify potential holt locations and determine when they are considered likely to be potentially active.

Features meeting the following criteria should be identified during surveys as 'potential holts':

- tunnel with internal diameter of at least 250mm and extending 1m into the bank or where the end is out of sight; or
- any cavity of similar dimensions: e.g. drain pipe; log pile; rock/boulder pile; under structures such as bridges or buildings.

Where any of the following signs are found at features meeting the potential holt criteria they should be considered potentially active:

- presence of otter spraints or footprints beside or inside tunnel;
- evidence of an animal's body rubbing against wall or roots;
- presence of hairs ca 25mm long and mid brown in colour; or
- presence of scratch marks.

Appendix E: Criteria for assessing potential otter breeding sites

Description of criteria

The following criteria devised by Paul Chanin (unpublished) should be used in assessing the potential for habitats in the vicinity of the route to support otter breeding sites.

Table E1: Cover

High	Dense impenetrable cover over more than 50% of the area, immediately adjacent to the river bank; or Presence of features with potential to conceal a breeding den such as fallen hollow trees, very large trees with spreading roots on river bank, small dense thickets of impenetrable vegetation, piles of boulders or other debris with space for a den beneath which are immediately adjacent to a waterway or connect to it by concealing routes.
Medium	Dense impenetrable cover over 20-50% of the area, immediately adjacent to the river bank or dense impenetrable cover over less than 50% of the area within 50m of the river with concealing routes between the bank and the area of dense cover; or Presence of features with potential to conceal a breeding den such as fallen hollow trees, small dense thickets of impenetrable vegetation, piles of boulders or other debris which are not adjacent to a waterway or connected to it by concealing routes.
Low	Dense impenetrable cover over less than 20% of the area. No features with potential to conceal a breeding den.
None	No dense impenetrable cover

Table E2: Food supply

High	Within 500m of high quality food supply (pond/lake of at least 1ha or river with depth greater than 0.5m and width greater than 5m).
Moderate	High quality food supply within 2km; or Within 500m of moderate food supply: (pond/lake of at least 0.5ha or productive river with depth greater than 0.3m and width greater than 3m).
Low	High quality food supply greater than 2km away; or Moderate quality food supply greater than 500m away.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Ecology and biodiversity – Ecological principles of mitigation

Contents

1 Introduction

1.1.1 This technical note documents the ecological principles that will be applied in designing the mitigation and compensation to be provided in support of the Proposed Scheme. Application of the principles outlined in this technical note to the detailed design of ecological mitigation and compensation aims to ensure that adverse effects that have been identified within the Environmental Statement (ES) are addressed and will not be exceeded.

1.1.2 The ES for the Proposed Scheme will be informed by desk based study and field survey. Where full survey cannot be undertaken due to access restrictions, a precautionary approach will be taken in the ES. Available information will be utilised to provide an assessment on a predicted precautionary basis, based on a 'reasonable worst-case' scenario.

1.1.3 At hybrid Bill submission the Proposed Scheme will still be subject to completion of detailed design, which includes landscape design. An outline landscape design will be available on submission of the hybrid Bill.

1.1.4 The ES will not contain all of the details of the mitigation or compensation required for impacts on protected and/or notable habitats and species. As a consequence, this technical note sets out the principles of the ecological mitigation strategy in order to provide confidence that the adverse effects will be adequately addressed. It also aims to support conclusions of no significant effect reported in the ES.

1.1.5 At all stages in the application of these principles full consideration has been and will be given to the implementation of the mitigation hierarchy (i.e. avoid-reduce-mitigate-compensate). Where it is reasonably practicable to do so then attempts have been made to avoid impacts. Where impacts cannot be avoided then efforts have been made to limit the extent and magnitude of the impact and to mitigate the resultant effects through the provision of appropriate measures. Where effects cannot be mitigated to a level where they are not significant then compensatory measures have been employed to offset any remaining adverse effects insofar as reasonably practicable.

1.1.6 This technical note deals principally with the last two steps in this mitigation hierarchy, namely the provision of mitigation and compensation. The land considered to be required for the implementation of such measures has been included in the Proposed Scheme on a precautionary basis, based on a 'reasonable worst-case'. Application of these principles of mitigation will act to guide the development of the detailed design of mitigation/ compensation measures to be provided in these areas.

1.1.7 Where mitigation and/or compensation are required, then the intention is to provide them within the confines of the land required for the construction of the Proposed Scheme, as defined on the Parliamentary plans. Further means of providing mitigation/compensation beyond the land controlled by the Proposed Scheme, will be considered where it is not reasonably practicable to provide it within the defined boundary described above, or if there are ecological benefits in doing so. Such provisions will be subject to agreements with relevant stakeholders.

2 Habitats

2.1 Key principles

2.1.1 The nominated undertaker will seek to ensure that, at the route-wide level, impacts on habitats as a consequence of the Proposed Scheme will not result in a permanent significant adverse effect on the conservation status of the habitats concerned.

2.1.2 A number of factors will need to be considered when considering the most suitable approach to addressing impacts to habitats. These will include ecological considerations, as well as how the approach fits with wider environmental or design constraints. The key principles that will be followed when considering the most appropriate approach to address impacts to habitats will include:

- the mitigation hierarchy;
- the Lawton principles[1];
- HS2 Ltd's Environmental Policy[2] (and the Principles within); and
- ensuring the approach considers landscape character, agricultural land uses, and the historic environment.

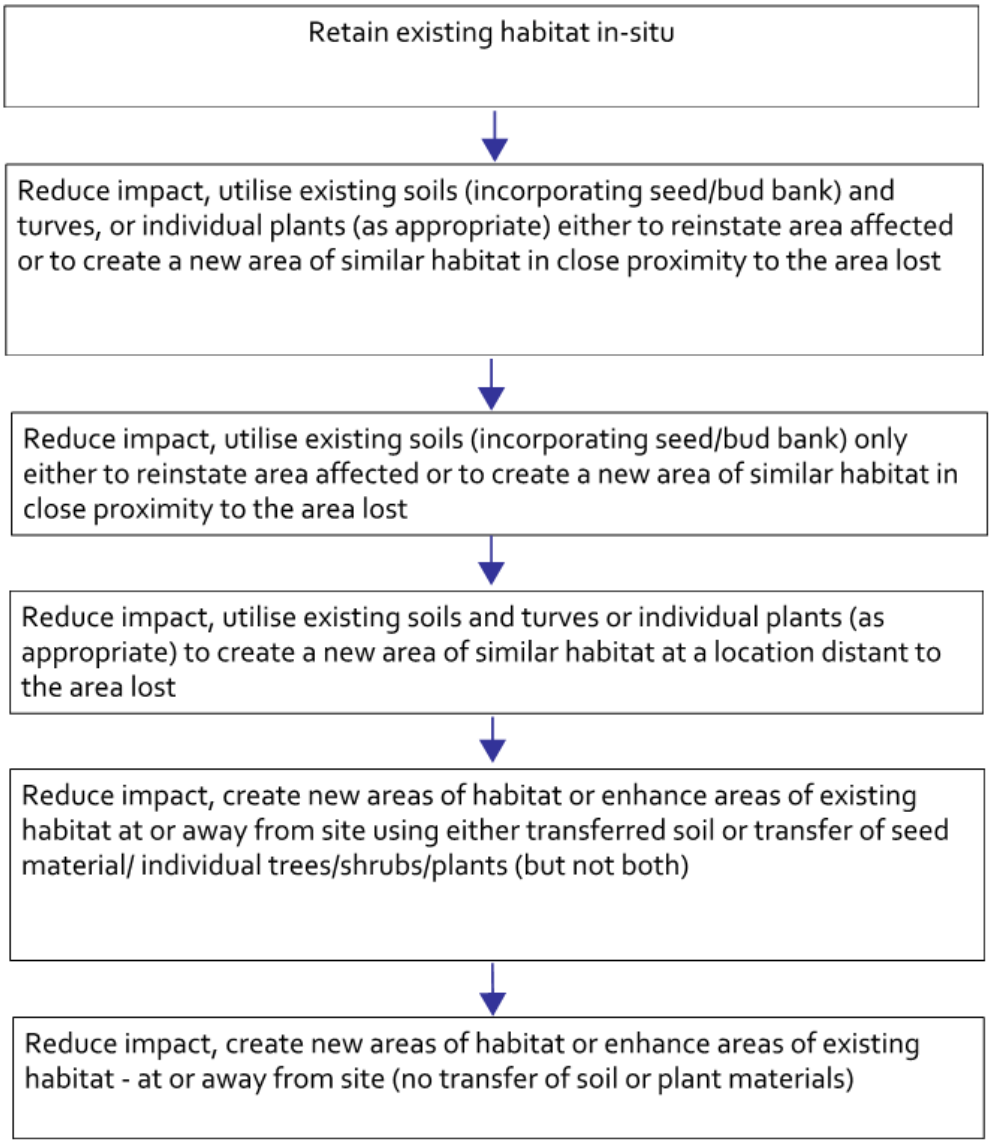
The mitigation hierarchy

2.1.3 The following mitigation hierarchy will be applied in considering the most suitable approach to mitigating potential habitat loss.

[1] Lawton, J (2010), *Making Space for Nature: A review of England's wildlife sites and ecological network*. Available online at: https://webarchive.nationalarchives.gov.uk/20130402170324/http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf

[2] High Speed Two Ltd (2019), *Environmental Policy.* Available online at: https://www.gov.uk/government/publications/hs2-environmental-policy

Figure 1: Mitigation hierarchy for habitats



The Lawton principles

2.1.4 Making Space for Nature: A review of England's Wildlife Sites and Ecological Network (Professor Sir John Lawton CBE FRS, 2010), otherwise known as 'the Lawton report', was a study commissioned by the Secretary of State for the Environment. The report set out some key principles which should be applied when rebuilding England's wildlife network.

2.1.5 When establishing the approach to provision of habitats to mitigate and compensate for impacts from HS2, the Lawton principles of *'more, bigger, better and joined'* will be taken into account.

Figure 2: Plans illustrating existing landscape and proposed landscape (with compensatory woodland planting in line with the Lawton principles)

Landscape character, agricultural land uses, historic environment

2.1.6 The design of ecological mitigation and compensation measures will take account of the local landscape character, including the characteristics of existing habitats and should have regard to adjacent land use and the historic environment.

2.2 Key habitat types

2.2.1 A wide range of habitats will be affected by the Proposed Scheme. Further details are provided here in relation to three key habitat types that will be subject to significant effects as a consequence of the Proposed Scheme. There will be many parallels in the approach adopted for other habitats.

2.2.2 Where it is not reasonably practicable to mitigate the impact of local habitat loss in-situ then opportunities will be taken to consolidate compensation provision as parts of larger scale habitat creation areas. All such compensation areas would be provided in close proximity to the route, where it is reasonably practicable to do so.

Woodland

2.2.3 Where areas of woodland habitat are affected by the Proposed Scheme the most appropriate form of mitigation will be decided through consideration of the factors identified in Section 2.1. The design should include provision for areas of woodland habitat creation through a combination of new planting and where appropriate, the salvage and translocation of soils from affected ancient woodlands. Where reasonably practicable, areas of new woodland should be adjacent to existing woodland or other high quality habitats or create linkages with existing woodlands.

2.2.4 When undertaking woodland creation though planting, the planting design and species selection should be informed by the ecological and physical characteristics of the woodland that is being lost. In all cases, planting will only utilise native species that are characteristic and appropriate to the area concerned. Both areas of new woodland habitat creation, and those translocated should be planted as early as reasonably practicable within the project programme.

2.2.5 Ancient woodland is irreplaceable and the nominated undertaker recognises that creation of newly planted woodland and translocation of ancient woodland soils cannot be considered as mitigation for these impacts. However, in order to provide compensation in the long term (outside the timeframe of the Proposed Scheme) the translocation of ancient woodland soils will be undertaken where appropriate. The measures taken in response to loss of ancient woodland will be set out in the Ancient Woodland Strategy document, which will not form part of the ES.

2.2.6 The target for new areas of woodland that will be to create of habitat of principal importance as defined under Section 41 of the Natural Environment and Rural Communities Act (2006)[3].

Grasslands

2.2.7 Where areas of unimproved or good quality semi-improved grassland habitat are affected by the Proposed Scheme the most appropriate form of mitigation will be decided through consideration of the factors identified in Section 2.1. The design should include provision for new areas of high value grassland creation through a combination of enhancement of retained grasslands, sewing of new grassland areas and the salvage and translocation of turfs from affected grasslands where appropriate.

2.2.8 Proposals should provide vegetation types that accord with the grassland habitat types identified as being priority for conservation in England within Section 41 of the NERC Act 2006; these include lowland meadow, lowland dry acid grassland, lowland calcareous grassland, coastal and floodplain grazing marsh and purple moor grass and rush pastures.

2.2.9 The chosen approach will ensure that areas identified for provision of grassland habitat creation are compatible with the target community identified. This as a minimum will include consideration of topography, drainage, aspect, and underlying soil type. The approach should also ensure the chosen habitat is resilient to climate change.

2.2.10 Only native species will be utilised, and seed mixes will aim to broadly mimic the species composition of local habitats. Where enhancement of the sward is proposed through the provision of a more diverse sward than was present previously only native species which are characteristic to the local area will be utilised. Where reasonable and worthwhile to do so, the collection of seed and/or plants from suitable donor sites will be considered.

[3] *Natural Environment and Rural Communities Act 2006*. Her Majesty's Stationery Office, London. Available online at: http://www.legislation.gov.uk/ukpga/2006/16/section/41.

2.2.11 When creating grasslands, consideration should be given to provision for pollinators in line with national guidance[4].

2.2.12 Grassland compensation areas will be planted as early as is reasonably practicable within the construction programme in order to allow maximum time for them to establish prior to the losses associated with construction.

2.2.13 Where translocation of grassland areas of high ecological value is justified and reasonably practicable then the most suitable method of translocation (as identified in Section 2.3) will be considered.

Hedgerows

2.2.14 Where hedgerows are affected by the Proposed Scheme the most appropriate form of mitigation will been decided through consideration of the factors identified in Section 2.1. The design should include provision for hedgerows through a combination of enhancement of retained hedgerows, planting of new hedgerows, and the salvage and translocation of hedgerows where appropriate.

2.2.15 In order to mitigate for the wider loss of hedgerow habitat, and the associated fragmentation of the existing hedgerow network the nominated undertaker will (where design of the Proposed Scheme and other practical considerations allow) replace those hedgerows which are lost.

2.2.16 The design and species composition should reflect the regional distinctiveness of hedgerows and utilise species of native provenance and where reasonably practicable will aim to provide hedgerow networks containing a wider range of appropriate native species than are currently present.

2.2.17 The translocation of specific hedgerows will be considered where the age, diversity and structure of these features is such that their loss as individual features will result in significant adverse effects. This will normally be where a hedgerow is a reason for the designation of a site of nature conservation importance such as a local wildlife site.

2.3 Translocation

2.3.1 Translocation of habitats is a costly process and does not always provide a habitat that is of higher value than that which can be reached through alternative approaches. As such it would not be reasonable or practical, for example, to undertake translocation of all grassland areas affected by the Proposed Scheme.

2.3.2 As a consequence in the consideration of the hierarchy for each site the following factors will be considered in deciding where it is appropriate to undertake translocation:

[4] Department of Environment, Food and Rural Affairs (2018). *National Pollinator Strategy Implementation Plan, 2018-2021.*

- ecological value/distinctiveness of habitat type;
- designation status;
- size;
- condition;
- nature of available receptors sites (e.g. topography, drainage, underlying soil type and species composition);
- likely content and condition of the seed bank; and
- ease and speed of recreating a similar habitat type through alternative means.

2.3.3 Where there is the potential for significant adverse effects on habitats of high ecological value then translocation of the affected area may be justified. Where this is the case it will be necessary to determine the most suitable form of translocation for the habitat type and area concerned. There are four main alternative types of translocation as follows (Anderson 2003[5] and JNCC 2003[6]):

- turf translocation (i.e. where an effort is made to partially maintain the integrity of the vegetation layer during the transfer, keeping the vegetation layer and the mass of underlying soil separated);
- soil translocation (where both the soils and the vegetation and scraped up and transferred together with no effort made to separate the two);
- moving trees and shrubs; or
- moving individual plants.

2.3.4 The most appropriate method will be determined on a site by site basis taking into account the nature and value of the habitats involved and the financial and other practical implications associated with each of the above methods.

2.3.5 Where translocation is undertaken the turves, soil or plants should be stripped and transferred to the receptor site immediately unless there are clear practical reasons for delay. Storage will increase risk of failure, but where necessary in the short term will be conducted according to best practice guidance (Anderson, 2003).

2.3.6 Detail of proposed translocation strategies for each site will be drawn up by ecologists experienced in works involving the translocation of the habitats concerned, with reference to current best practice guidance (e.g. Anderson, 2003).

Woodlands

2.3.7 Where translocation is identified as being a reasonable and worthwhile approach for a woodland one or more of the following measures, may be appropriate:

[5] Anderson, P. (2003), *Habitat translocation: a best practical guide*. CIRIA, London.

[6] Joint Nature Conservation Committee (2003), *A habitats translocation policy for Britain*. JNCC, Peterborough.

- soil translocation;
- translocation of veteran trees;
- translocation of coppice stools, and other small trees; and/or
- translocation of fallen or standing deadwood.

2.3.8 Translocation of some or all of the above elements of ancient woodland will enable some of the valuable elements of the existing ancient woodland ecosystems to be retained within the newly created areas. Soil testing and seed viability trials will be conducted prior to translocation at all locations identified in order to ensure that conditions are suitable.

2.3.9 The nature of wet woodland means that the methods of translocation differ from that for dry woodlands. Where translocation of wet woodland is proposed the mechanisms and logistics of translocation will have particular emphasis on the consideration of the hydrological, hydrochemical and hydrogeological conditions. In addition, the gradient of the land and flooding probability should be explored in detail in order to ensure that the donor site is sufficiently inundated to maintain wet woodland habitat.

2.3.10 Woodland translocation should take place in the dormant season in autumn/early winter under normal weather conditions.

Grasslands

2.3.11 Where translocation is considered to be appropriate for a grassland, translocation of turves will normally be the preferred option. However, the cohesiveness of the sward will also be taken into account. Turf translocation will not be reasonably practicable where turf contains significant elements of bare ground or lacks turf cohesiveness (Anderson, 2003). In addition, it may not be possible to utilise turf translocation where steep slopes or undulating ground are present.

2.3.12 Where soil translocation is proposed, prior to translocation a selection of seed bank tests will be conducted in order to test the viability and content of the existing seed bank.

2.3.13 Where wet or marshy grassland are to be translocated then specific focus will be given to ensuring that the hydrological regime of the receptor site is manipulated in order that it provides suitable groundwater conditions to support the target habitat in question.

2.3.14 The detailed mechanics of each translocation will be influenced by best practice guidance (e.g. Anderson, 2003) in consultation with experienced ecologists, and contractors experienced in large scale habitat translocation.

Hedgerows

2.3.15 Where justified, translocation will be undertaken according to current best practice guidance, with detailed mechanisms for these works devised by suitably experienced ecologists, in conjunction with contractors that are experienced in undertaking such works.

Receptor sites

2.3.16 When translocating a habitat the process will be dependent upon the suitability of the chosen receptor site. Efforts have been made to select receptor sites that are compatible with the target habitat types concerned based on comparison of the following factors:

- hydrological conditions;
- soil type;
- topography;
- connections to other ecological habitats; and
- size of site; and
- accessibility.

2.3.17 In all cases prior to translocation soil sampling and works to establish ground water levels should be undertaken and used in the detailed design of mitigation areas. In addition, in some instances trials may be necessary in order to establish the content and viability of the seed bank.

2.3.18 Where identified receptors sites are not fully compatible with the target community then remedial works will be undertaken to ensure that the surrounding, physical, chemical and hydrological soil and substrate conditions are similar or more suitable than those at the donor site.

2.4 Management and maintenance

2.4.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

2.4.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the Environmental Minimum Requirements (EMR)[7] agreed at Royal Assent.

[7] The Environmental Minimum Requirements (EMR) are a series of commitments which will be agreed with stakeholders and made by HS2 Ltd at the point of Royal Assent. They aim to ensure that impacts that have been identified within the Environmental Statement are addressed and will not be exceeded.

3 Great crested newt

3.1 Key principles

3.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the favourable conservation status (FCS) of those great crested newt populations located in the vicinity of the route.

3.1.2 The nominated undertaker will seek to provide new aquatic and terrestrial habitat for great crested newt primarily within locations that have connectivity with retained habitat that is already utilised by the populations affected (i.e. in-situ). In doing so compensatory habitat creation will seek to avoid any long term effect on FCS through ensuring that the key impacts of habitat loss (both aquatic and terrestrial) and potential severance are addressed. Such provision will include both the creation of new core areas of habitat specifically designed for great crested newt, and the enhancement of compensation areas which have already been incorporated to address losses of particular habitat types. For example, the design of areas of broadleaved woodland planted to compensate for losses of this habitat type may be altered to allow these areas to also incorporate great crested newt breeding ponds.

3.1.3 However, for a scheme of this scale it is likely that there will be locations where there is no-satisfactory alternative to providing compensatory habitat in locations that are distant from the impact. Where this approach is necessary then disease screening (including that for chytridiomycosis) will be undertaken in line with current best practice to ensure that all populations involved are free from disease at time of translocation.

3.1.4 Where it is not reasonably practicable to address the possible impact of the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. Where reasonably practicable to do so, all such compensation areas would be provided in close proximity to the route, through the creation of areas of high quality terrestrial and aquatic habitat.

3.1.5 As well as providing a receptor for those populations where translocation in-situ is not possible due to other constraints, large scale habitat creation areas have been provided within the land required for the construction of the Proposed Scheme to address a 'reasonable worst-case' in relation to those ponds which it is has not been possible to access for survey. Such areas have been provided at regular intervals throughout the route in order to minimise impacts on the conservation status of the populations concerned at the local level.

3.1.6 The presence of the operational railway is likely to reduce exchange of individuals between water bodies either side of the route, and in some cases (e.g. where the route is in deep cutting or on steep sided embankment) then it has the potential to act as a barrier to movement.

3.1.7 Where severance is identified as having the potential to result in an adverse effect on conservation status, the nominated undertaker will seek to minimise its effects through

implementing habitat creation/restoration to increase connectivity with other known areas of suitable habitat in the landscape, and maintain the viability of these severed elements, for example by providing linear connectivity and new ponds which will promote connectivity between two previously separate metapopulations.

3.1.8 In extreme situations where it is not considered possible to maintain the viability of severed fragments of a population affected by the Proposed Scheme then the nominated undertaker will consider the trapping of great crested newts from land that lies outside the extent of the Proposed Scheme, in order to allow the full population to be relocated to the same receptor site.

3.1.9 The use of amphibian tunnels as a potential method for addressing the effects of severance will be considered on a case by case basis and reviewed against the current evidence basis for their effectiveness at the time of construction. However, based on the current limited evidence for their effectiveness such measures are currently not relied upon in the mitigation/compensation strategy outlined in the ES.

3.1.10 Mitigation measures will be consistent with the requirements identified in the appropriate licence. This may be the route-wide organisational licence or a site specific licence.

3.2 Aquatic habitat creation

3.2.1 Where ponds supporting great crested newt are lost then they will be compensated through either:

- provision of two replacement ponds (of similar size) for each pond lost (a minimum pond surface area of 100m^2 would be applied); or
- provision of approximately double the surface area of suitable aquatic habitat through the creation of larger ponds than those lost (a minimum pond surface area of 100m^2).

3.2.2 Where possible replacement ponds will be provided in locations that maintain connectivity with retained elements already utilised by the populations affected (i.e. in-situ). Ponds should be sited so as to provide resilience to possible future changes to hydrology which may arise through climate change.

3.2.3 New ponds will be located in areas that are not likely to be subject to high levels of human or animal disturbance where reasonably practicable. In addition, surrounding terrestrial habitat creation and on-going management will be designed to avoid dense shading.

3.2.4 When identifying the location for replacement ponds, consideration will be given to current and future land uses in the local area.

3.2.5 When developing the approach for provision of great crested newt ponds, the key consideration will be maintaining the favourable conservation status of the population. Where possible, new ponds will be created within 500m of retained great crested newt breeding ponds.

3.2.6 The construction schedule will ensure that where ponds are to be lost then any new ponds will (wherever reasonably practicable to do so) be created six months prior to the commencement of any translocation works in order to allow the plant and invertebrate populations to establish.

3.2.7 The planting regime will be appropriate to the local area, and in each case will include a variety of marginal, floating and submerged vegetation with some areas of open water. Where possible plant material and/or water from ponds to be lost will be used to promote rapid establishment of newly created ponds.

3.3 Terrestrial habitat creation

3.3.1 Where an adverse effect is anticipated on great crested newt as a result of the loss of terrestrial habitat then the nominated undertaker will provide compensatory habitat.

3.3.2 Provision will seek to maximise the quality of terrestrial habitat provided with regard to great crested newt and ensure this is provided in close proximity to either retained or newly created ponds. However, provision of habitat in proximity must be balanced with the need to ensure that links with other areas of surrounding suitable terrestrial habitat are maintained.

3.3.3 The loss of intermediate and distant terrestrial habitat is unlikely to result in adverse effects on those great crested newt populations where the quality and availability of terrestrial habitat in close proximity to the pond is high. However, in some cases such areas may play a key role. As such in all cases the requirement and scale of replacement terrestrial habitat will be considered on a case-by-case basis by ecologists experienced in European protected species mitigation (EPSM) licensing.

3.3.4 Where the requirement for compensatory habitat provision is identified, the nominated undertaker will endeavour to provide habitat of equal or higher quality than that which is lost. Habitats of similar type to those that are lost will be provided and hibernacula and other above ground refugia will be provided in each area of terrestrial habitat creation in order to maximise their potential carrying capacity.

3.3.5 Where replacement habitat is of equal quality to those areas lost then the area of replacement provision will be at least as large as the area lost (i.e. minimum of 1:1 ratio).

3.3.6 Where the quality of the terrestrial habitat to be provided post-construction will clearly be higher than that available pre-development, or habitat will be provided closer to the breeding pond, then compensation habitat areas provided may be on a less than 1:1 ratio. This may only be undertaken where it is not considered to be detrimental, to the population concerned, or the potential movement of amphibians through the wider landscape.

3.3.7 Planting of terrestrial compensation areas should utilise native species appropriate to the local area, and where possible will seek to maximise the value of such areas for other species, without compromising their value for great crested newt.

3.3.8 All hibernacula, bunds and other refugia incorporated into the final designs will be constructed in accordance with current best practice guidelines (e.g. English Nature; 2001[8] ; Langton et al 2001[9]).

3.3.9 Where newly created habitats are to act as receptor areas for great crested newt these areas will (wherever reasonably practicable to do so) be constructed a minimum of six months to one year in advance of the commencement of translocation (depending on the type and seasonal timing of the works conducted).

3.4 Mitigating impacts to individual newts

3.4.1 The approach to mitigating impacts to individual newts should be guided by a number of factors including the mitigation hierarchy, Defra's Licensing Policies – LP's[10], and any great crested newt mitigation licences which may be in place. Defra's Licensing Policies result in a reduction in the requirements for fencing-off construction boundaries and reduce the time of capture, relocation and translocation exercises, in favour of strategically protecting or creating high quality GCN habitats which are of high value to populations.

3.4.2 Where necessary, capture and exclusion works will be undertaken in accordance with best practice guidelines, as currently detailed in the Natural England advice notes referenced at Section E4 in tab "E-Mitign & compn", of Form WML-A14-2[11]. Implementation of these methods will prevent any legal offences resulting from the killing/injury of great crested newt during site clearance.

3.4.3 Wherever it is reasonable to do so, a controlled drain down of water bodies known to support breeding populations will be undertaken during the period mid-September to February inclusive, in order to minimise impacts on existing populations.

3.4.4 Novel sustainable solutions to minimise the extents of exclusion fencing required by the Proposed Scheme will be explored and agreed with Natural England. Exclusion fencing (or equivalent) will be maintained for the duration of construction at those locations where there is considered to be a risk of amphibians re-entering construction areas post habitat clearance.

3.4.5 Any required permanent exclusion fencing will be incorporated in those locations where the operation of the Proposed Scheme represents a significant risk to the favourable

[8] English Nature (2001), *Great Crested Newt Mitigation Guidelines*. English Nature, Peterborough.

[9] Langton, T.E.S., Beckett, C.L., and Foster, J.P. (2001), *Great Crested Newt Conservation Handbook*. Froglife, Halesworth.

[10] Natural England (2016), *New licensing policies: great for wildlife - great for business.* Available online at: https://www.gov.uk/government/news/new-licensing-policies-great-for-wildlife-great-for-business.

[11] Natural England (2012), *Template for method statement to support application for licence under Regulation 532(2)e in respect of great crested newts Triturus cristatus.* Form WML-A14-2 (Version December 2015). Available online at:

https://www.gov.uk/government/publications/great-crested-newts-apply-for-a-mitigation-licence.

conservation status of the populations concerned, or where the presence of great crested newt within key areas of operational infrastructure has the potential to significantly constrain operational requirements.

3.5 Management, maintenance and monitoring

3.5.1 The nominated undertaker will commit to providing appropriate on-going management, maintenance and monitoring of compensatory habitats.

3.5.2 Details of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies and will form part of the EMR to be agreed at Royal Assent.

3.5.3 Detailed management, maintenance and monitoring strategies would be provided alongside derogation licence applications post Royal Assent.

4 Common amphibians

4.1 Key principles

4.1.1 Where populations of common amphibians utilise the same areas of habitat used by great crested newts then effects on these species will be addressed through adherence to the principles of mitigation outlined in Section 2.1 of this technical note.

4.1.2 Where common amphibians occur in areas where great crested newt are absent then mitigation and compensatory habitat provision will seek to avoid significant effects on the populations concerned.

4.1.3 All new water bodies provided for common amphibians will be placed within areas of suitable terrestrial habitat that are being provided primarily to compensate for habitat losses as a consequence of the Proposed Scheme. These areas will be enhanced as necessary to also provide suitable replacement habitat for common amphibian populations.

4.1.4 Where translocation will involve movement of individuals to locations outside of the normal extent of that population then disease screening (including that for chytridiomycosis) will be undertaken in line with current best practice to ensure that all populations involved are free from disease at time of translocation.

4.2 Aquatic habitat creation

4.2.1 Where ponds containing other common amphibians are lost then these would be replaced on at least a 1:1 basis and be of similar size and form to those lost.

4.2.2 This will be achieved through the provision of new water bodies suitable for use by common amphibians within the areas identified for provision of ecological mitigation/compensation outlined in the ES (Volume 2: Map series CT-06).

4.3 Terrestrial habitat creation

4.3.1 Where the quality of the terrestrial habitat to be provided post-construction will be higher than that available pre-development, or habitat will be provided closer to the breeding pond, then compensation habitat areas may be on a less than 1:1 ratio. This may be undertaken where it is not considered to be detrimental to the population concerned, or the potential movement of amphibians through the wider landscape.

4.3.2 Planting of terrestrial compensation areas should utilise native species appropriate to the local area. Hibernacula, bunds and other refugia will be provided as required in line with current best practice guidelines (e.g. English Nature, 2001[12]; Langton et al, 2001[13]).

4.3.3 Where newly created habitats are to act as receptor areas for common amphibians, these will (wherever reasonably practicable to do so) be constructed a minimum of 12 months in advance of the commencement of translocation (depending on the type and seasonal timing of the works conducted).

4.4 Capture and exclusion

4.4.1 Wherever it is reasonable to do so a controlled drain down of water bodies known to support breeding populations of common amphibians will be undertaken during the period mid-September to February inclusive, in order to minimise impacts on existing populations.

4.4.2 Based on the legal status of common amphibian the use of exclusion fencing and pitfall trapping will only be utilised where there is considered to be the potential for sufficiently high numbers of common amphibians to be killed or injured during construction that there would be a significant adverse effect on the population concerned. As a general rule the requirement for exclusion fencing and pitfall trapping will be considered in those locations which are known to support good or exceptional common amphibian populations.

4.5 Management, maintenance and monitoring

4.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

4.5.2 Details of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies and will form part of the EMR to be agreed at Royal Assent.

4.5.3 Detailed management, maintenance and monitoring strategies would be provided alongside derogation licence applications post Royal Assent where protected amphibians are present.

[12] English Nature (2001), *Great Crested Newt Mitigation Guidelines.* English Nature. Peterborough.

[13] Langton, T.E.S., Beckett, C.L., and Foster, J.P (2001), *Great Crested Newt Conservation Handbook*, Froglife, Halesworth.

5 Bats

5.1 Key principles

5.1.1 The nominated undertaker will ensure that impacts as a consequence of the construction and operation of the Proposed Scheme do not result in any long term adverse effect on the FCS of bat populations in the vicinity of the Proposed Scheme.

5.1.2 The nominated undertaker will seek to provide new roosting and commuting habitats for bat species primarily within locations that have connectivity with retained habitat that is already utilised by the populations affected (i.e. in-situ). In doing so compensatory habitat creation will seek to avoid any long term effect on FCS through ensuring that the key impacts of habitat loss (in relation to foraging, commuting and roosting activity), disturbance and potential severance are addressed. Such provision will include both the creation of new roost sites, and the enhancement of those compensation areas provided to address general habitat loss as a consequence of the Proposed Scheme, in order to make these areas more suitable for bats. For example, the design of areas of broadleaved woodland planted to compensate for loss of woodland habitat may be altered to provide a graded woodland edge that will be suitable for foraging activity of a range of bat species, or bat boxes incorporated to provide immediate replacement roosting opportunities.

5.1.3 Where it is not reasonably practicable to mitigate the likely effect on the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. All such compensation areas would (where reasonably practicable to do so) be provided in the closest most suitable location taking into consideration the following factors:

- type of roost;
- position in landscape; and
- design of the railway (for example in a cutting or at grade).

5.1.4 Large scale habitat creation areas will be provided as part of the wider ecological mitigation/compensation package in order to address a 'reasonable worst-case' scenario for all species in those areas where access has prevented full survey being conducted. Such areas will be at regular intervals throughout the route in order to minimise impacts on the FCS of the populations concerned at the local level.

5.1.5 Mitigation measures will be consistent with any requirements identified in relevant bat licences issued by Natural England/NatureScot.

5.2 Replacement roosting provision

5.2.1 Where bat roosts are lost they will be compensated in a form appropriate to the species of bat and type of roost in accordance with the guidance provided in Figure 4 of the Bat Mitigation Guidelines (Mitchell-Jones 2004)[14].

5.2.2 Each roost to be lost would be compensated for as part of the mitigation scheme as set out either in the individual species licence or the Bat Mitigation Class Licence. The timing of operations such as provision of new roosting habitat, exclusion from roosts, and destruction will be appropriate to the nature of the roost to be lost with works conducted in accordance with the recommendations of the Bat Workers Manual (JNCC 2004)[15].

5.2.3 Where a roost will be lost or disturbed as a consequence of works required in support of the Proposed Scheme, the hierarchy, shown in Figure 3 will be applied in considering the most appropriate way to mitigate for its loss.

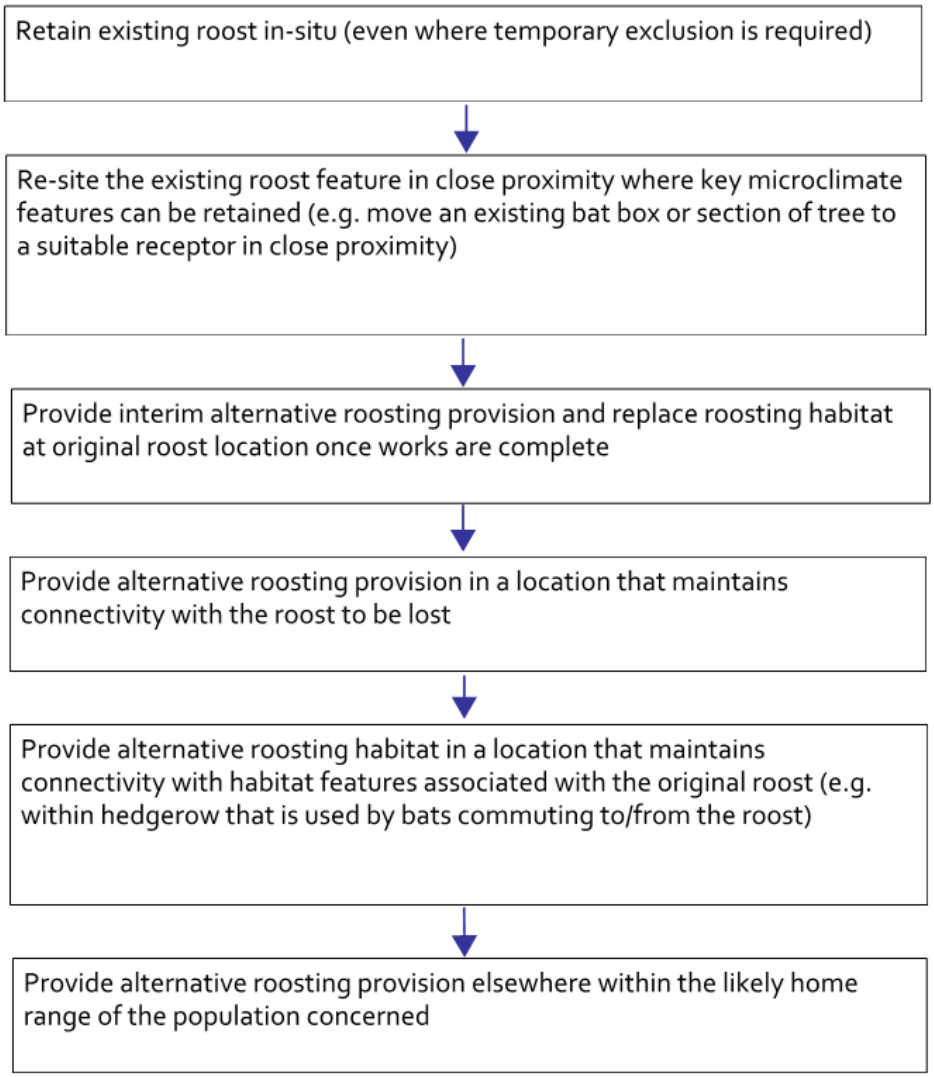
5.2.4 In considering the hierarchy in relation to individual roosts lost the following key factors will be considered:

- type of roost;
- species;
- likely sensitivity to disturbance;
- risk of train strike during operation (including risk of drawing more bats close to the line through the provision of roosting provision in proximity to the Proposed Scheme);
- nature of surrounding habitat;
- likely or known pattern of dispersal within the habitat;
- proposed planting scheme; and
- design of the Proposed Scheme in this area (e.g. is the line in cutting or at grade).

[14] Mitchell-Jones, A.J. (2004), *Bat Mitigation guidelines*. English Nature, Peterborough.

[15] Joint Nature Conservation Committee (2004), *Bat worker's Manual,* 3rd Edition, edited by A.J. Mitchell-Jones and A.P. McLeish.

Figure 3: Mitigation hierarchy to be applied when a bat roost is lost



5.2.5 Replacement roosting habitat will be provided in a form and quantum that is most appropriate to the specific location in question. Across the route of the Proposed Scheme it is anticipated that a wide range of replacement roost types will be utilised ranging from the production of bespoke 'bat houses' and hibernation sites, incorporation of roosting habitats into existing structures, the provision of a variety of bat boxes, and the use of tree surgery to provide artificial roosting features within retained trees.

5.2.6 Replacement roosting habitat will be provided both where roosts are lost and where there is considered to be a significant reduction in the available potential roosting resource that could affect the long term status of bat assemblages which occur in the local area. Where the reduction in the available roosting resource has the potential to result in significant adverse effects, compensatory roosting provision will be provided at appropriate levels on a case by case basis. No strict provision ratios are proposed (e.g. two bat boxes for each high potential tree lost), and efforts will be made to consolidate roosting provision and ensure a

range of compensatory habitat provision is provided, rather than simple deployment of bat boxes only.

5.3 Replacement foraging habitat

5.3.1 Habitat losses within the land required for the construction of the Proposed Scheme may require some bats to travel further and expend more energy during regular foraging and movement throughout their home range for the duration of construction. However, such effects alone (in isolation of those resulting from habitat fragmentation/severance resulting from these losses) are for all species considered unlikely to result in sufficient disturbance of the populations concerned during the period of construction to result in an adverse effect on their conservation status.

5.3.2 Compensatory habitat creation that will be provided to address significant effects on specific habitat types (e.g. ancient semi-natural woodland) will act to prevent any longer term effect on bat populations as a consequence of the losses anticipated. Compensatory habitats to be created will include a range of new woodland, grassland, and water bodies.

5.3.3 No mitigation/compensatory planting will be provided with the primary aim of addressing losses of bat foraging habitat since planting to be provided to address other significant effects will act to fulfil this function. Where there is particular benefit in doing so, the final planting scheme and maintenance regime will, whilst taking account of the multiple functions of such areas, incorporate details that maximises the value of these habitat features in relation to bats (e.g. through scalloping woodland edges to provide sheltered areas that will support concentrations of insects and promote bat foraging).

5.4 Mitigating for habitat fragmentation/severance (construction)

5.4.1 The removal or disturbance of habitat features that are utilised by bats during breeding, hibernation or during seasonal migrations between roosts (e.g. moving from hibernation to maternity roost locations) have the potential to result in adverse effects on the bat populations or assemblages during construction. However, the point at which such impacts are likely to result in a significant adverse effect on the conservation status of the population concerned will differ dependent on the status and behaviour of the species concerned. As such the requirement for mitigation measures to address the effects of habitat fragmentation/severance arising as a result of construction will be considered based on both the species and its conservation status.

5.4.2 Where habitat severance/fragmentation arising as a result of construction is identified as having the potential to result in an adverse effect on bat populations the nominated undertaker will seek (wherever it is reasonably practical to do so) to minimise its effects through:

- influencing the construction programme (where reasonably practicable to do so) in order to ensure works are sensitively seasonally timed in order to minimise impacts;
- retaining key habitat elements that are demonstrated to be of significant value for the movement of bats through the landscape for as long as possible during construction, giving time for replacement linear features to become established and minimising disruption to ecological functionality (e.g. construction of a new over-bridge in parallel with one known to be utilised by bats crossing the existing railway line in order to minimise disruption);
- implement replacement habitat creation/restoration as early as is reasonably practical to do so in project programme, in order to minimise the duration and scale of habitat fragmentation/severance effects;
- use of measures such as 'artificial hedgerows', wattle screens or other artificial measures to provide linear flight lines of use to bats during construction and until such point that planting is sufficiently established to fulfil this function;
- reinstating suitable hedgerows on the route of known existing flight lines and increasing the connectivity with other known areas of suitable habitat in the wider landscape; and
- avoiding night time working in proximity to key commuting/foraging features.

5.5 Minimising disturbance of roosts during construction

5.5.1 During the construction phase the following mitigation measures will (wherever it is reasonably practicable to do so) be implemented in order to prevent the disturbance of retained roosts:

- avoiding night-time working in proximity to known roosts;
- security lighting to be directed away from roost entrances; and
- timing of activities which could result in disturbance of known roosts to be controlled and wherever possible to be conducted during the times of the year when bats would not be present, e.g. October to April inclusive for maternity roosts.

5.5.2 Where this guidance cannot be followed and the proposed works are likely to cause disturbance, the procedures identified within relevant EPS licences issued by Natural England/NatureScot will be adopted.

5.6 Minimising risk of collisions with trains/vortices during operation

5.6.1 The potential for the operation of the Proposed Scheme to result in adverse effects on bats as a consequence of train strike and associated vortices will be considered for each location on a species by species basis taking into account the following factors:

- flight habit and preference;
- position within geographical range of the species;
- conservation status; and
- baseline information on activity of the population concerned.

5.6.2 Where there is considered to be the potential for an adverse effect on the conservation status of the bat species concerned then the following measures will (where reasonably practicable to do so) be utilised to ensure there is no long term effect on the FCS of the species concerned:

- provision of green bridges, ecological underbridges and culverts, or the enhancement or 'greening' of existing structures in order to facilitate passage of bats across the route;
- where the above features are required efforts will be made to include these early in the construction programme in order to maximise the time available for the establishment of associated landscaping;
- use of planting to create 'hop-overs' where new road diversions are introduced as part of the Proposed Scheme at key locations where bats are known to be at risk;
- provision of new planting to 'funnel' bats to the new crossing points, and the use of artificial measures (e.g. wattle screens) on a temporary basis until establishment of planting, in order to facilitate use of the above features;
- planting to strengthen existing alternative flight routes through the wider landscape that are sufficiently separated from the effects of disturbance or vortices associated with the operational railway;
- degradation and removal of some existing vegetation in proximity to the route of the Proposed Scheme in order to reduce the suitability of habitats for foraging bats in areas of high risk for sensitive species; and
- avoiding operational lighting close to proposed bat crossing points and, conversely, using lighting in other locations in order to direct bats to cross the route at proposed bat crossing points.

5.6.3 Mitigation/compensation provision will be provided at a level appropriate to ensure that by the commencement of operation likely effects are reduced to a level where any killing/injury through train strike and/or the effects of turbulence will be sufficiently low to have confidence that there will be no detrimental effect on the favourable conservation status of the species concerned. As such the level and form of mitigation/compensation required will differ between species based on the status of the populations concerned.

5.7 Management, maintenance and monitoring

5.7.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of mitigation features and compensatory habitat provision.

5.7.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies and will form part of the EMR agreed at Royal Assent.

5.7.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

6 Otter

6.1 Key principles

6.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the FCS of otter populations in the vicinity of the route of the Proposed Scheme.

6.1.2 The nominated undertaker will seek to provide safe passage for otter across the route of the Proposed Scheme throughout construction and during operation. This commitment will apply to all points at where the Proposed Scheme crosses watercourses that are either known to be utilised by otter or are considered to have the potential to be utilised by otter in the future. This commitment acknowledges the on-going expansion of otter populations across the UK that is likely to continue during construction and into the period of operation of the Proposed Scheme.

6.1.3 Where works are likely to cause disturbance of otter or interference or damage to a holt a EPSM licence will be sought from Natural England/NatureScot.

6.2 Provision of replacement holts

6.2.1 Loss of otter holts has the potential to result in an adverse effect on FCS of the population concerned. Where the loss of holts cannot be avoided then the nominated undertaker will seek to mitigate adverse effects on the FCS of the populations concerned by creating artificial holts.

6.2.2 Replacement provision will seek to maximise the quality and likelihood of use of an artificial holt, in accordance with the following key principles:

- provision of two new artificial holts for every one lost;
- artificial holts will be sited in an undisturbed area, free from flooding and close to a good supply of food;
- where reasonably practicable to do so, one of the replacement holts will be provided in close proximity to the original holt that was lost when construction in the vicinity is complete. The other will be provided in a nearby area of suitable habitat that will not be subject to disturbance during the period of construction;
- design of replacement holts will seek to replicate the form and complexity of the holt lost, ranging from simple log piles with entrance points, to more complex structures consisting of pipes and engineered cavities;
- artificial holt will be located on the same watercourse as the holt to be lost; and
- artificial holts will be created at least 12 months in advance of scheduled holt loss in order to given otter time to investigate and become acclimatised to the artificial holts.

6.2.3 The design and siting of artificial holts, alongside the methodology for excluding otters from existing holts will be co-ordinated by a consultant with experience in mitigation design for otters.

6.3 Mitigating disturbance during construction

6.3.1 Where watercourses known to support otter cross the route of the Proposed Scheme there is the potential for disturbance, killing and injury of otter. This will be avoided through implementing the following principles (wherever it is reasonably practicable to do so) at those locations where otters are known to be present:

- avoiding lighting of watercourses known to be utilised by otter through directing lights away from the watercourse and any associated holt locations;
- avoiding placement of site compounds in close proximity to watercourses;
- using fencing to guide otters to temporary safe crossing points for the duration of construction works or watercourse realignment works;
- providing a safe means by which otter can safely escape any deep excavations in the vicinity of suitable watercourses;
- securing chemicals and machinery overnight when working near watercourses; and
- limiting noise and vibration in the vicinity of retained known holts.

6.4 Maintaining safe passage

6.4.1 Design will aim to ensure that where the route of the Proposed Scheme crosses watercourses which support otter (or are potentially suitable to do so in the future) a means of safe passage for otter will be maintained.

6.4.2 All culverts will be designed to be suitable to allow passage for mammals such as otter and water vole, taking into account flood events, or will have an alternative dry tunnel installed.

6.4.3 Mammal proof fencing in line with the specification provided in the Design Manual for Roads and Bridges (Highways Agency, 2001)[16] will be provided in association with crossing points wherever deemed necessary to ensure their effectiveness, and where necessary to prevent otters gaining access to the active railway line.

[16] Highways Agency (2001), *Design Manual for Roads and Bridges. Volume 10 Environmental design. Section 4 - Nature Conservation.* Part 4 HA81/99 Nature Conservation advice in relation to otters. Her Majesty's Stationery Office. Available online at: https://www.standardsforhighways.co.uk/dmrb/.

6.5 Management, maintenance and monitoring

6.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of mitigation features and compensatory habitat provision.

6.5.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed in consultation with key statutory bodies and will form part of the EMR agreed at Royal Assent.

6.5.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

7 Badgers

7.1 Key principles

7.1.1 The nominated undertaker will ensure that mitigation and compensation provided for badger populations affected by the Proposed Scheme will avoid significant adverse effects.

7.1.2 The nominated undertaker will provide compensation for the loss of main and annex setts and seek to maintain safe passage for badgers across the route of the Proposed Scheme.

7.1.3 Due to the limited legal protection afforded to badger and its widespread nature throughout the route of the Proposed Scheme, mitigation/compensation for the effects of habitat severance will only be provided where it is clear that in the absence of its provision a legal offence would occur.

7.1.4 Mitigation measures will be consistent with requirements identified in the relevant badger licence, be that a route-wide licence or site specific licence.

7.2 Loss of habitat - maintaining safe passage across the Proposed Scheme

7.2.1 No specific habitat creation for badger will be undertaken. Losses in habitats that were suitable for use by badger prior to construction will be addressed through compensation provided to address wider habitat loss as a consequence of the Proposed Scheme. This will provide large areas of woodland and grassland which will become suitable to provide replacement habitat for badger.

7.2.2 Where the territory of a social group will be severed to the extent that it may result in a significant adverse effect on the conservation status of the population concerned then the use of measures to maintain safe passage of badger across the route of the Proposed Scheme will be explored. Where significant effects are anticipated then the effects of habitat severance and fragmentation will be minimised by the installation of appropriately designed and positioned passageways beneath or over the railway.

7.2.3 Where badger tunnels are provided then the following features will be considered:

- siting tunnel on or near a known badger path wherever it is practical to do so;
- good habitat connectivity with existing landscape features such as hedges; and ditches:
- good vegetation cover around the tunnel entrance;
- ensuring adequate drainage is incorporated into the design; and
- tunnel diameter of at least 600mm.

7.3 Mitigating effects arising during the construction of the Proposed Scheme

7.3.1 During the construction phase, activities that may pose a temporary threat to badgers or disturb them whilst they are in nearby setts will be controlled. These will include some or all of the following:

- security lighting to be directed away from setts;
- chemicals to be stored as far away from setts and badger paths as possible;
- trenches to be covered at the end of each working day, or to include a means of escape from the animal falling in;
- water sources for badgers to be safeguarded;
- trees to be felled away from setts and must not block badger paths; and
- disturbances such as loud noise or vibration that might agitate badgers occupying a sett to be avoided or limited to areas sufficiently distant from setts to avoid disturbance.

7.4 Creation of artificial setts

7.4.1 Where main setts are to be lost as a consequence of works associated with the construction of the Proposed Scheme and there are no suitable alternative setts, the nominated undertaker will provide an artificial sett. Where annex setts are lost, artificial setts will be provided where necessary in agreement with Natural England.

7.4.2 As far as is reasonably practicable artificial setts will be provided in locations that maintain connectivity with retained setts, key foraging areas and well used paths utilised by the badgers affected. Artificial setts will be constructed to include chambers and tunnels and will aim to replicate as much as possible the characteristics of the natural setts they replace. In all cases replacement setts will be provided within the appropriate social group territory.

7.4.3 Artificial setts will, where possible, be created at least six months prior to closures of the setts they replace in order to provide some time to allow badgers to investigate and become acclimatised to the artificial sett. Food baiting will be conducted periodically following the construction of the new sett, up to the point of closure of the existing sett, in order to encourage the badgers to locate and begin to utilise the new sett.

7.4.4 Artificial setts will be positioned in suitable locations to ensure that there will be sufficient drainage to avoid flooding and planted to ensure cover and lack of disturbance.

7.4.5 When siting new setts those locations which are subject to high levels of human or animal disturbance will be avoided where reasonably practicable. In addition, to avoid issues in the future, consideration will be given to future adjacent land uses such as housing developments.

7.4.6 Where the proposed works are likely to cause sett interference a licence to disturb a badger sett will be sought from Natural England/NatureScot.

7.5 Management, maintenance and monitoring

7.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

7.5.2 Detailed management, maintenance and monitoring strategies for individual locations will be consistent with the requirements of the relevant route-wide or site-specific badger licence.

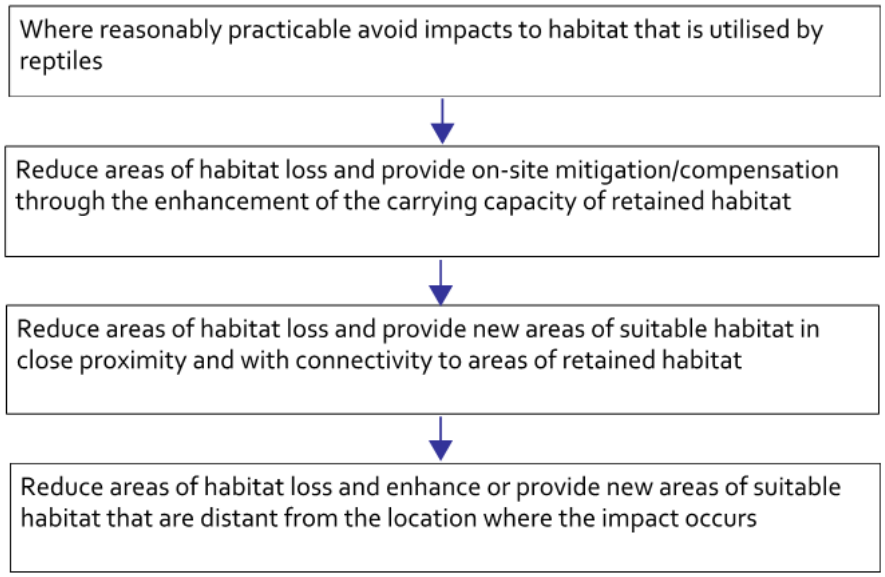
8 Reptiles

8.1 Key principles

8.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term adverse effect on the conservation status of populations of common reptile (slow worm, adder, grass snake and common lizard) in the vicinity of the route of the Proposed Scheme.

8.1.2 In addressing the potential loss of areas of habitat known to be used by common reptiles, the mitigation hierarchy, shown in Figure 4, will be applied:

Figure 4: Mitigation hierarchy for habitat utilised by reptiles



8.1.3 Where translocation will involve movement of individuals to locations outside of the normal extent of that population then disease screening will be undertaken in line with current best practice to ensure that all populations involved are free from disease at time of translocation.

8.1.4 Once constructed the railway is for the majority of the route considered unlikely to form an absolute barrier to reptile movement. Reptiles are known to utilise habitats that are common to operational railway corridors such as south facing embankments for basking.

8.1.5 Where severance is identified as having the potential to result in an adverse effect on conservation status the nominated undertaker will seek to minimise its effects through implementing habitat creation/restoration to increase connectivity with other known areas of suitable habitat in the landscape and maintain the viability of these severed elements.

8.1.6 The use of reptile tunnels as a potential method for addressing the effects of severance has been rejected on the basis of a lack of clear evidence demonstrating their effectiveness.

8.2 Creation of replacement habitat

8.2.1 Where a significant adverse effect on common reptiles will occur then the nominated undertaker will act to provide sufficient replacement habitat to ensure the conservation status of the population is maintained in the long term.

8.2.2 No adherence to a strict ratio for balancing losses to gains is proposed. Consideration of the extent of terrestrial habitat required to address losses as a consequence of the Proposed Scheme will be undertaken by an experienced ecologist and will take into account both the habitat area and quality that is to be provided.

8.2.3 Where replacement habitat is of equal quality to those areas lost then the area of replacement provision will be at least as large as the area lost (i.e. minimum of 1:1 ratio).

8.2.4 Where it is not reasonably practicable to mitigate the impact on the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. All such compensation areas would be provided (where reasonably practicable to do so) in close proximity to the route, through the creation of high quality areas of terrestrial habitat, integrated with mitigation/compensation provision for other species.

8.2.5 Habitats of similar type to those that will be lost will be provided and bunds, hibernacula and other above ground refugia will be provided in each area of terrestrial habitat creation in order to maximise their potential carrying capacity.

8.2.6 Planting of terrestrial compensation areas will utilise native species appropriate to the local area, and where possible will seek to maximise the value of such areas for other species, without compromising their value for reptiles.

8.2.7 All hibernacula, bunds and other refugia incorporated into the final design will be constructed in accordance with current best practice guidelines (e.g. Herpetofauna Workers Manual, Gent and Gibson 2003)[17].

8.3 Capture, exclusion and habitat manipulation

8.3.1 Where areas of habitat loss are limited and compensation will be provided within areas with direct connectivity to the areas lost then (where reasonably practicable to do) progressive degrading of the habitat to be lost will be conducted in order to encourage reptiles to move into new habitats. The requirement for additional capture and exclusion to augment this process will be considered on a case by case basis taking into consideration the population size, habitat quality and complexity of habitats concerned.

[17] Gent, T. and Gibson, S. (2003), *Herpetofauna Workers Manual*. Joint Nature Conservation Committee, Peterborough.

8.3.2 Where required capture and exclusion will be undertaken in accordance with the current best practice guidelines at the time of construction.

8.3.3 Wherever it is reasonably practicable to do so translocation will commence a minimum of 12 months prior to the required start of construction. For complex sites supporting high population size classes then a longer lead in period may be necessary in order to ensure the site is cleared prior to construction.

8.3.4 Exclusion fencing will be maintained for the duration of construction at those locations where there is considered to be a risk of reptiles re-entering construction areas post habitat clearance.

8.3.5 Permanent exclusion fencing will be provided in those locations where the operation of the scheme represents a significant risk to reptile populations or where the presence of reptiles within key areas of operational infrastructure have the potential to significantly constrain operational requirements.

8.4 Management, maintenance and monitoring

8.4.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

8.4.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the EMR agreed at Royal Assent.

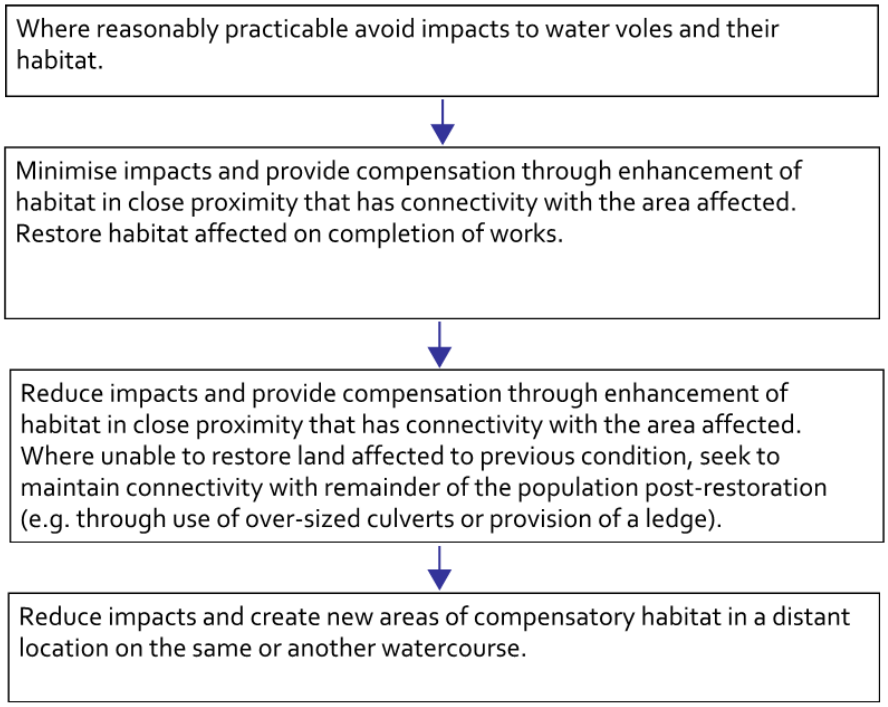
9 Water vole

9.1 Key principles

9.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any significant effects on the conservation status of water vole populations in the vicinity of the Proposed Route.

9.1.2 The nominated undertaker will mitigate for effects on water vole by applying the following mitigation hierarchy, as described in The Water Vole Conservation Handbook (Strachan et al, 2011)[18]:

Figure 5: Mitigation hierarchy for water vole



9.1.3 Where it is not reasonably practicable to mitigate the impact on the local population in-situ then opportunities will be taken to consolidate compensation provision as part of larger scale habitat creation areas. All such compensation areas would (where reasonably practicable to do so) be provided in close proximity to the route, through the creation of areas of suitable bank and riparian habitat.

[18] Strachan, R., Moorhouse, T., and Geling, M. (2011), *Water Vole Conservation Handbook - Third Edition*. Wildlife Conservation Research Unit, Abington.

9.2 Provision of replacement habitat

9.2.1 Wherever reasonably practicable to do so the nominated undertaker will compensate for the loss and/or disturbance of existing water vole habitat through the creation of replacement habitat of a similar quantity and quality. This may be achieved either through the enhancement of existing habitat within the same or linked watercourses, or through the creation of new habitat, following guidance in The Water Vole Mitigation Handbook (Dean et al, 2016)[19].

9.2.2 Replacement habitat will be provided as close to the area affected as it is reasonably practicable to do so.

9.2.3 Where it is reasonably practicable to restore the habitats which are to be affected during construction then this will be conducted as soon as possible following the completion of construction.

9.2.4 Where enhancement of existing habitats is proposed and there is likely to be seasonal use, then such enhancements works that are required will be undertaken outside of this season in order to avoid potential killing or injury of individuals.

9.2.5 Where replacement habitat or improvement of existing habitat is undertaken then these works will be undertaken prior to the removal of the habitat to be affected by construction. Wherever it is reasonably practicable to do so new habitats will be created at least a full growing season in advance of the proposed translocation in order to allow the new areas of habitat to establish.

9.3 Capture and habitat manipulation/displacement

9.3.1 The most appropriate method for clearing water voles from areas to be affected by the proposed works will be considered on a site by site basis taking into account the following factors:

- size of habitat area affected;
- likely number of individuals affected;
- seasonal timing of the works; and
- the proposed method of providing mitigation/compensation as defined by the output from applying the mitigation hierarchy above.

9.3.2 Where it is reasonably practicable to do so and thought likely to be successful based on expert opinion, habitat manipulation will be used to encourage the displacement of individuals to areas of suitable retained or enhanced habitat in adjoining sections of the

[19] Dean M, Strachan R, Gow D and Andrews R (2016), *The Water Vole Mitigation Handbook (The Mammal Society Mitigation Guidance Series).* The Mammal Society, London.

same watercourse through progressive removal of bankside vegetation. Use of displacement will be favoured where the area affected is limited in extent, only likely to support a relatively small number of animals, where there is sufficient alternative habitat available, and/or relocating animals by trapping is likely to be disproportionately expensive. Where utilised, habitat manipulation will be conducted in accordance with the best practice guidelines provided in The Water Vole Mitigation Handbook (Dean et al, 2016)[14].

9.3.3 Where displacement is considered unsuitable based on consideration of the factors identified in paragraph 9.3.1, trapping of water voles will be undertaken in accordance with the guidelines provided in The Water Vole Mitigation Handbook (Dean et al, 2016) and standing advice from Natural England/Department for Environment, Food and Rural Affairs (2015) on water voles[20].

9.3.4 Where translocation to a site distant to the area affected is proposed and there is the potential for interaction of a previously isolated population, appropriate disease screening will be conducted prior to commencement of the full scale capture and release programme.

9.3.5 In some circumstances where it is not appropriate to translocate the population or to encourage the use of adjacent habitats, it may be necessary to take voles into a captive breeding programme. This approach may be suitable where it is possible to return water voles to their original location following the completion of temporary works, but no options for displacement or off-site translocation are viable. In addition captive breeding may be appropriate where the trapped population is of limited size and therefore will be of increased risk of detrimental effect from the pressures of immediate translocation. Where this is necessary captive breeding will be undertaken by those experienced and qualified to do so, in order to build up the number of voles to a level where it is considered that the population can be self-sustaining on their release.

9.4 Minimising effects of habitat fragmentation

9.4.1 Wherever it is reasonably practicable to do so the nominated undertaker will seek to ensure that the construction of the Proposed Scheme avoids fragmentation of water vole habitat, which has the potential to result in adverse effects on the functioning of the water vole population of the wider local area.

9.4.2 The potential for fragmentation will be considered during mitigation design. In extreme situations where it is not reasonably practicable to maintain the viability of severed fragments of a population affected by the Proposed Scheme then the nominated undertaker will consider the trapping of water voles from isolated fragments of habitat outside the extent of Proposed Scheme in order to allow the full population to be relocated to the same receptor site and maintain its viability in the long term.

[20] Natural England and Department for Environment, Food and Rural Affairs (2015), *Water voles: surveys and mitigation for development projects*. Available online at: https://www.gov.uk/guidance/water-voles-protection-surveys-and-licences.

9.4.3 All culverts will be designed taking account of the guidance in The Water Vole Mitigation Handbook (Dean et al., 2016)[14], and be suitable to allow passage for mammals such as otter and water vole, taking into account flood events, or will have an alternative dry tunnel installed.

9.5 Management, maintenance and monitoring

9.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats, taking account of the guidance in The Water Vole Conservation Handbook (Strachan et al, 2011).

9.5.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the EMR agreed at Royal Assent.

9.5.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

10 White clawed crayfish

10.1 Key principles

10.1.1 The nominated undertaker will ensure that impacts as a consequence of the Proposed Scheme do not result in any long term significant adverse effects on the FCS of white clawed crayfish populations in the vicinity of the Proposed Scheme.

10.1.2 Where it is reasonably practicable to do so, bank and channel works will be conducted in small sections, with progressive reinstatement to limit the reduction in the availability of suitable habitat. In addition, measures will be implemented to prevent siltation and pollution of watercourses.

10.1.3 Where it is necessary to conduct works in areas where white clawed crayfish are confirmed to be present, the nominated undertaker will seek to provide replacement suitable habitat in close proximity to the areas of habitat affected (within a few hundred metres) and within sections of the same watercourse (or tributaries of it) that are already used by individuals of the same population. Such provision will be made in advance of the proposed works, allowing any crayfish captured during clearance works to be released into these locations. In doing so the aim will be to avoid any long term effect on the conservation status of the population concerned.

10.2 Avoiding and mitigating effects during construction phase

10.2.1 During the construction phase where white clawed crayfish are known to be present the following measures will be implemented as appropriate with the aim of avoiding or mitigating adverse effects which could occur during construction:

- security lighting to be directed away from riverbanks and watercourses;
- chemicals to be stored as far away from watercourses as possible;
- monitoring to ensure no adverse siltation of downstream locations;
- reducing disturbance to riverbank;
- maintaining existing water levels and water flow; and
- reducing removal of bankside vegetation and trees.

10.3 Capture and exclusion

10.3.1 Where required crayfish removals will consist of a combination of both trapping and destructive searching of potential refuges prior to construction, and controlled draw-down under ecological supervision. Works would be conducted according to the key principles identified in Peay (2000)[21] which include the following:

- undertaking trapping and destructive clearance of refuges immediately in advance of the proposed works;
- retention of stones suitable for use during restoration;
- where possible erect a temporary barrier to prevent access from adjoining sections of the channel which are not subject to works;
- ecological supervision throughout draw-down to catch crayfish as they emerge from refuges;
- destructive clearance of all structures and habitats suitable for possible use by crayfish on completion of draw-down; and
- relocate crayfish to identified receptor site as soon as reasonably practicable.

10.3.2 Exclusion of crayfish from construction areas will be conducted during the suitable seasonal windows of either April or July to October inclusive, when the water temperature is 4°C or higher (Standing Advice from Natural England and Department for Environment, Food and Rural Affairs (9 October 2014)[22]. Works will not take place during late May or June to avoid disturbance to breeding females with attached young. Current best practice guidance for disease screening and biosecurity will be implemented at all times.

10.3.3 Where an adverse effect is anticipated on white clawed crayfish then the requirement for creation of replacement habitat in close proximity on the same watercourse will be considered, in order to provide an appropriate receptor site.

10.3.4 Where enhancement of existing habitat is undertaken this will seek to achieve the following in order to provide suitable habitat to support crayfish:

- improved water quality;
- reduced siltation;
- increased refuge availability;
- removal of any alien crayfish; and
- more appropriate type and structure of aquatic and bankside vegetation.

[21] Peay, S. (2002), *Guidance on Habitat for White Clawed Crayfish and its restoration*. Environment Agency Technical Report W1-067/T.

[22] Natural England and Department for Environment, Food and Rural Affairs (2014), *White-clawed crayfish: surveys and mitigation for development projects*. Available online at: https://www.gov.uk/guidance/white-clawed-crayfish-protection-surveys-and-licences.

10.3.5 All enhancement works will be completed prior to the commencement of the clearance of affected habitat. Suitable measures for each location where such works are required would be agreed in conjunction with Natural England/NatureScot and the Environment Agency/Scottish Environmental Protection Agency (SEPA) prior to the commencement of construction.

10.3.6 Where additional refuges are provided these will be of sizes to support both adults and juveniles and may be provided through a variety of measures including provision of stone on the bed or in banks; engineering suitable crevices into below water man- made structures; and additional wood or vegetation along the banks.

10.3.7 Once construction works have been completed, where compatible with the design and operation of the Proposed Scheme, areas of habitat affected by the construction of the Proposed Scheme will be reinstated so that the bank and channel are suitable for white clawed crayfish.

10.3.8 If the use of an 'ark site' is deemed necessary, then a suitable site will be selected in consultation with relevant consultees in accordance with the guidance provided in Ark sites for white clawed crayfish - guidance for the aggregates industry (Whitehouse et al 2009)[23].

10.4 Management, maintenance and monitoring

10.4.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

10.4.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the EMR agreed at Royal Assent.

10.4.3 Detailed management, maintenance and monitoring strategies for individual locations will be provided alongside derogation licence applications post Royal Assent.

[23] Whitehouse, A.T., Peay, S. and Kindemba, V. (2009*), Ark sites for White-Clawed Crayfish - Guidance for the aggregates industry*. Buglife - The invertebrate Conservation Trust, Peterborough.

11 Fish

11.1 Key principles

11.1.1 The nominated undertaker will ensure that mitigation and compensation provided for fish populations affected by the proposed scheme will seek to ensure no permanent significant adverse effects occur.

11.1.2 The extent of areas affected by culverts, watercourse realignment and dewatering will be reduced as far as reasonably practicable. In addition, where reasonably practicable, works will be sensitively timed in order to minimise impacts on the species concerned.

11.2 De-watering

11.2.1 Where dewatering is required to facilitate construction then current best practice methods will be implemented to ensure that all fish from such areas are safely removed and relocated. The capture methodology utilised will take into account the physical features of the water course involved; the species involved; likely numbers; and timing of proposed works. The final methodology will be agreed with the Environment Agency/SEPA.

11.2.2 Permits will be obtained from the Environment Agency/SEPA for all fish movements undertaken in support of the Proposed Scheme. This process includes the requirement for disease screening.

11.3 Fish passage

11.3.1 Where reasonably practicable temporary diversions will be utilised to maintain the safe passage of fish and reduce effects during construction. Where appropriate this may involve the creation of a temporary diversion channel with suitable sized replacement substrate or transplanted substrate from the section being dewatered in order to ensure that the size and flow in the diversion channel replicates the existing channel as closely as possible.

11.3.2 Reinstated watercourses and new alignments will be designed where reasonably practicable to provide habitats of increased complexity and quality.

11.3.3 If potential significant effects on fish populations are identified as a consequence of potential restrictions to fish movement then the potential to provide fish passage will need to be reconsidered. If required, the fish passages will be designed to facilitate the upstream and downstream movement of fish and other aquatic fauna.

11.4 Mitigation during construction

11.4.1 During the construction phase activities that may pose a temporary threat to fish (in particular migratory species) or disturb them will be mitigated against. These will include some or all of the following:

- artificial lighting directed away from water surfaces during construction/operation of Proposed Scheme;
- chemicals to be stored as far away from watercourses as reasonably practicable; and
- activities that may cause pollution and sedimentation will be controlled by approved measures.

11.5 Management and maintenance

11.5.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

11.5.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the EMR agreed at Royal Assent.

12 Invertebrates

12.1 Key principles

12.1.1 The nominated undertaker will ensure that mitigation and compensation provided for aquatic and terrestrial invertebrate populations affected by the Proposed Scheme will ensure no permanent adverse effect on the aquatic and terrestrial invertebrate populations in the vicinity of the Proposed Scheme.

12.1.2 Given the wide range of protected and/or notable invertebrate species it is not possible here to provide specific mitigation principles for all species. Instead broad principles are provided that will apply to the majority of aquatic and terrestrial invertebrate species. In all cases where significant effects are identified then specific mitigation proposals will be developed that reflect the limited ecological niche occupied by many invertebrate species.

12.1.3 Potential significant effects on protected and/or notable species will be reduced by wherever reasonably practicable ensuring that at least some areas of the existing suitable habitat for the species concerned is retained to provide a 'source' to colonise areas of mitigation/compensatory habitat to be provided.

12.1.4 In addition, where reasonably practicable to do so, suitable compensatory habitat provided to address significant effects will be created as early as possible within the project programme in order to maximise time available for these areas to establish in advance of losses. Such provision would where reasonably practicable be provided in suitable proximity to allow an element of natural dispersal of the species concerned prior to any habitat loss as a consequence of the Proposed Scheme.

12.1.5 Compensatory habitat provision provided to address significant effects on invertebrates will in general look to mimic the structure and form of the existing nearby habitats which support the population concerned.

12.1.6 Where reasonably practicable to do so some plant material or elements of the areas affected may be transferred to the area of mitigation/compensatory provision in order to increase the likelihood that the target species will occupy the new habitat areas provided (e.g. the transfer of standing dead wood from ancient woodlands to be lost where this habitat element is known to play an important part in the lifecycle of the species concerned; or the transfer of water or aquatic vegetation to speed the establishment of aquatic invertebrate populations in newly created ponds).

12.1.7 In addition, the following measures would be implemented where it is reasonably practicable to do so:

- conducting clearance of affected habitats at an appropriate time of the year based on the life-cycle of the species concerned; and
- retaining elements of suitable habitat for the species concerned as long as reasonably practicable during construction in order to maximise the potential for newly created habitats to become established.

12.1.8 Habitat creation to be provided for other primary purposes (i.e. not specifically to address significant effects on invertebrates) will in the longer term also serve to provide habitat suitable for a range of invertebrate species.

12.1.9 When creating habitats, consideration should be given to provision for pollinators in line with national guidance (Defra[24]).

12.2 Management and maintenance

12.2.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats.

12.2.2 Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the EMR agreed at Royal Assent.

[24] Department of Environment, Food and Rural Affairs (2018), *National Pollinator Strategy Implementation Plan*, 2018-2021.

13 Birds

13.1 Key principles

13.1.1 The nominated undertaker will ensure that where reasonably practicable the Proposed Scheme will avoid permanent significant adverse effects on birds, including those species listed in Schedule 1 of the Wildlife and Countryside Act 1981 (as amended)[25].

13.1.2 Due to the scale and complexity of the Proposed Scheme it will not be feasible to avoid all such impacts and as such mitigation and/or compensation will be provided where in the absence of this provision there is the potential that a significant adverse effect may arise.

13.1.3 Where there is a significant reduction in the availability of nesting or roosting habitat as a consequence of the Proposed Scheme then consideration will be given to the requirement for specific mitigation and or compensation in relation to birds, i.e. in addition to those ecological mitigation/compensation measures that will mitigate impacts on bird populations but for which they are not the primary purpose.

13.1.4 Wherever is reasonably and practicable to do so habitat clearance will be conducted outside of the periods where the species or species concerned will be breeding. Through sensitive timing of works it is aimed to reduce disturbance of birds, and the potential for wasted breeding effort.

13.1.5 The loss of potential breeding habitats from within land required for the construction of the Proposed Scheme will as a general rule be addressed in the long term through the replacement habitat provided for landscaping and ecology purposes. Where there is the potential for additional adverse effects to occur prior to these habitats maturing then the option of providing alternative suitable habitat will be considered.

13.1.6 Evidence suggests that mortality of barn owl may result in the loss of all breeding populations of barn owls within 1.5km of the Proposed Scheme. Following recent research into the dispersal of barn owl these losses will be addressed through exploring opportunities to provide barn owl nesting boxes in areas greater than 3 km from the route with local landowners to enhance barn owl populations in existing habitats that would not be affected by the Proposed Scheme.

13.2 Management and maintenance

13.2.1 The nominated undertaker will commit to appropriate on-going management, maintenance and monitoring of compensatory habitats. Detail of route-wide commitments to on-going management, maintenance and monitoring will be developed alongside key statutory bodies and will form part of the EMR agreed at Royal Assent.

[25] *Wildlife and Countryside Act (1981),* Chapter 69. Her Majesty's Stationery Office, London.

Annex F – Technical note: Electromagnetic interference

The following technical note is contained in this annex:

- Electromagnetic interference – Assessment methodology.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Electromagnetic interference – Assessment methodology

Contents

1 Electromagnetic interference (EMI)

1.1 Introduction

1.1.1 This technical note describes the detailed methodology for carrying out, analysing and reporting the assessment of the likely effects of electromagnetic fields (EMF) generated by construction and operation of the Proposed Scheme.

1.1.2 Electric and magnetic fields are produced wherever electricity is used. The electric field is produced by voltage and the magnetic field by current. EMF cause the following types of effect:

- interference to electric and electronic equipment. This is called electromagnetic interference (EMI) and is the disturbance that affects an electrical system due to magnetic and electric fields, electromagnetic induction or electromagnetic radiation emitted from an external source; and
- the potential to cause harmful effects in the human body through EMF.

1.1.3 Electromagnetic compatibility (EMC) is the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to other equipment in that environment.

1.1.4 The methodology described in this technical note considers the principal sources of EMI and EMF that could arise from the Proposed Scheme that may have an effect on third parties along the route of the Proposed Scheme, in particular from the traction power supply system. Emissions from the rolling stock, signalling and communication systems, electrical and mechanical systems, generally only affect the internal railway operating system and are therefore not considered further as having a wider potential effect.

1.1.5 There is also a requirement to address the EMF exposure, and the possible risk from exposure of the general public and workers to electromagnetic fields generated by the Proposed Scheme, in line with current United Kingdom (UK) Government recommendations.

1.2 Legal context

1.2.1 The Electromagnetic Compatibility Directive 2014/30/EU[1] has been incorporated in the UK as a Statutory Instrument as the Electromagnetic Compatibility Regulations 2016. The UK regulations require that equipment shall be so designed and manufactured, having regard to the state of the art, as to ensure that:

- the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment can operate as intended; and

[1] Official Journal of the European Union (2014), *The Electromagnetic Compatibility Directive 2014/30/EU.*

- it has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use.

1.2.2 A fixed installation shall be installed applying good engineering practices and respecting the information on the intended use of its components. With regard to the Proposed Scheme, the scope of the EMI assessment is concerned with emissions from the Proposed Scheme only which will be installed with a view to meeting the requirements set out in bullet point 1 of paragraph 1.2.1 of this technical note. A fixed installation is defined as a particular combination of several types of apparatus, and where applicable, other devices, which are assembled, installed and intended to be used permanently at a predefined location.

1.2.3 The railway network and its components (e.g. a signalling system) are considered to be a fixed installation under the terms of the regulations.

1.2.4 For EMF exposure of the general public and workers, the reference levels based on short-term effects are found within the International Commission on Non-Ionising Radiation Protection (ICNIRP) guidelines for limiting exposure to time varying electric and magnetic fields. The limits within these guidelines will consider:

- occupational exposure; applicable to non-residential premises[2]; and
- public exposure; applicable to residential properties[3].

1.2.5 For the assessment, the generic immunity standards will be applied to assess risk to electrical equipment: BS EN 61000-6-1:2019[4] for residential, commercial and light industrial environments and BS EN 61000-6-2:2019[5] for industrial environments.

1.2.6 Immunity for residential, commercial and light industrial environments will be referred to as 'residential' within this technical note.

1.2.7 The Proposed Scheme will be built to comply with the BS EN 50121 series of standards, Railway Applications, Electromagnetic Compatibility, which contains the following parts:

- BS EN 50121-1:2017 Part 1: General[6];

[2] International Commission on non-ionizing radiation protection (2010), Guidelines for limiting exposure to time - varying electric, magnetic and electromagnetic fields (1Hz to 100 kHz).

[3] International Commission on non-ionizing radiation protection (1998), 'Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)', Health Physics, 74 (4): pp. 494-522.

[4] British Standards Institution (2019), BS EN 61000-6-1:2019. Electromagnetic compatibility Part 6.1: Generic standards- immunity for residential, commercial and light industrial environments.

[5] British Standards Institution (2019), BS EN 61000-6-2:2019. Electromagnetic compatibility Part 6.2: Generic standards - immunity for industrial environments.

[6] British Standards Institution (2017), BS EN 50121-1:2017. Railway applications - Electromagnetic compatibility Part 1: General.

- BS EN 50121-2:2017 Part 2: Emissions of the whole railway system to the outside world[7];
- BS EN 50121-3-1:2017+A1:2019 Part 3-1: Rolling stock - train and complete vehicle[8];
- BS EN 50121-3-2:2016+A1:2019 Part 3-2: Rolling stock – apparatus[9];
- BS EN 50121-4:2016+A1:2019 Part 4: Emissions and immunity of the signalling and telecommunications apparatus[10]; and
- BS EN 50121-5:2017+A1:2019 Part 5: Emissions and immunity of fixed power supply installations and apparatus[11].

1.2.8 The series of standards described above are intended to permit compliance with the EMC Directive (EU Directive 2014/30/EU), but also provides a means of prescribing compatibility between the internal parts of the railway. These standards identify maximum limits of electromagnetic disturbance at the railway boundary, which is defined as 10m from the centre of the nearest track (BS EN 50121-1).

1.2.9 The Proposed Scheme will also comply with the BS EN 50122 series, Railway Applications - Fixed installations - Electrical safety, earthing and the return circuit, which consists of:

- BS EN 50122-1:2011+A4:2017 Part 1: Protective provisions against electric shock[12];
- BS EN 50122-2:2010 Part 2: Provisions against the effects of stray currents caused by d.c. (direct current) traction systems[13]; and
- BS EN 50122-3:2010 Part 3: Mutual Interaction of a.c. (alternating current) and d.c. traction systems[14].

[7] British Standards Institution (2017), BS EN 50121-2:2017. Railway applications - Electromagnetic compatibility Part 2: Emissions of the whole railway system to the outside world.

[8] British Standards Institution (2017), BS EN 50121-3-1:2017+A1:2019. Railway applications - Electromagnetic compatibility Part 3- 1: Rolling stock - train and complete vehicle.

[9] British Standards Institution (2016), BS EN 50121-3-2:2016+A1:2019. Railway applications - Electromagnetic compatibility Part 3- 2: Rolling stock – apparatus.

[10] British Standards Institution (2016), BS EN 50121-4:2016+A1:2019. Railway applications - Electromagnetic compatibility Part 4: Emissions and immunity of the signalling and telecommunications apparatus.

[11] British Standards Institution (2017), BS EN 50121-5-2017+A1:2019. Railway applications - Electromagnetic compatibility Part 5: Emissions and immunity of fixed power supply installations and apparatus.

[12] British Standards Institution (2017), BS EN 50122-1:2011+A4:2017. Railway Applications - Fixed installations - Electrical safety, earthing and the return circuit. Part 1: Protective provisions against electric shock.

[13] British Standards Institution (2006), BS EN 50122-2:2010 - Railway applications. Fixed installations. Electrical safety, earthing and the return circuit. Provisions against the effects of stray currents caused by d.c. traction systems.

[14] British Standards Institution (2006), BS EN 50122-3:2010. Railway applications. Fixed installations. Electrical safety, earthing and the return circuit. Mutual Interaction of a.c. and d.c. traction systems.

1.2.10 In addition the following regulations and standards are applicable:

- Control of Electromagnetic Fields at Work Regulations 2016 (CEMFAW 2016)[15], which enact EU Directive 2013/35/EU Electromagnetic Fields (EMF) limits;
- BS EN 50499:2019[16] Procedure for the assessment of the exposure of workers to electromagnetic fields and covers the essential requirements of the proposed EMF Directive;
- EC Recommendation 1999/519/EC on the limitation of exposure of the general public to electromagnetic fields (0Hz to 300GHz)[17], provides levels for public exposure to EMF based on limits provided by ICNIRP 1998; and
- The Railways (Interoperability) Regulations 2011[18].

1.2.11 Electromagnetic Field (EMF) limits for workers are specified in the EU Directive 2013/35/EU[19], published in 2013 and enforced in the UK by the Control of Electromagnetic Fields at Work Regulations 2016 (CEMFAW 2016). Currently, the limits provided by ICNIRP 2010 are applicable and can be used during design and installation.

1.3 Requirements

1.3.1 The requirements for EMC will be met throughout the life of the Proposed Scheme by adhering to the guidelines, technical specifications and industry best practice at the design, installation, testing and commissioning stages.

1.3.2 To assist with the environmental impact assessment, baseline data will be collected and evaluated to assess the vulnerability of the existing environment against the effects of the Proposed Scheme and its operation. This will be undertaken as a desk-top study.

[15] *The Control of Electromagnetic Fields at Work Regulations 2016. (SI 2016/588), Her Majesty's Stationary Office, London.*

[16] British Standards Institution (2008), *BS EN 50499:2019. Procedure for the assessment of the exposure of workers to electromagnetic fields.*

[17] Official Journal of the European Union (1999), *EC Recommendation 1999/519/EC on the limitation of exposure of the general public to electromagnetic fields (0Hz to 300GHz).*

[18] *The Railways (Interoperability) Regulations 2011.* Her Majesty's Stationery Office, London.

[19] *Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from the physical agents (electromagnetic fields) 2013.* Strasbourg, European Parliament and European Council.

2 Scope and methodology

2.1 Electromagnetic risk

2.1.1 An electrified railway has the potential to introduce EMI and EMF risks through the generation of electromagnetic fields, which have the potential to effect human health and interfere with electronic equipment. In addition the transmission of high voltage electricity can induce potentially harmful voltages into adjacent cables, metallic structures and the human body. It is these risks that may affect third parties external to the railway and are to be considered in order to prepare the Environmental Statement (ES).

2.1.2 Emissions from the signalling and communication systems, electrical and mechanical systems, generally only affect the internal railway operating system and are not considered in this analysis.

2.1.3 Power supplies used for construction are generally not sufficient to cause major EMI or EMF problems. Tunnel boring machines generally use a high voltage supply for their operation, typically 11kV three phase. The levels of EMF emissions are generally insufficient to cause any adverse effect. In both cases good engineering practice should be followed in accordance with EMC standards.

2.1.4 Within the construction corridor that will be acquired to build the Proposed Scheme, most buildings that would be potentially at risk will be demolished. It is not therefore, anticipated that any electromagnetic impact on people would occur. Some buildings may remain close to the Proposed Scheme and hence there may be risk of interference for some sensitive electrical equipment or equipment in residential, commercial and industrial properties.

2.1.5 EMI and EMF issues during operation of the Proposed Scheme will be limited to those caused by the traction current within the overhead line electrification system. Emissions from rolling stock, signalling and other electrical infrastructure such as trackside non-traction electrical distribution, are not high enough to cause effects outside the railway boundary.

2.2 Areas at risk

2.2.1 An electrified railway has the potential to affect the operation of susceptible equipment adjacent the railway. Examples of potential sensitive sites that may be at risk and are to be considered as part of this assessment are:

- universities;
- schools;
- hospitals;
- military establishments;
- airports;

- radio telescope operators;
- emergency and commercial radio stations;
- residential properties; and
- industrial properties.

2.2.2 Magnetic fields generated by current flowing within the overhead line traction distribution system, have the potential to cause harmful effects in the human body.

2.2.3 Power lines and other aerial cable routes that run parallel to the railway for any significant distance may be affected by induced voltages from the overhead line electrification system if placed too close together.

2.2.4 Other services such as underground pipelines are susceptible to induced voltage, if they are metal and run parallel for any significant distance.

2.3 Secondary areas

2.3.1 Where overhead power lines and their supporting structures have to be moved to enable safe construction of the Proposed Scheme, an assessment of the effect of the relocated power line will be undertaken, to ensure that it does not introduce any EMI or EMF that is detrimental to its new surroundings.

2.3.2 The National Grid in its publication Development near overhead lines[20] indicates that magnetic fields generated by 275/400kV overhead power lines are in the order of 4 microTesla (μT) at 10m from the centreline. BS EN 61000-6-1 specifies residential immunity of 3 Amperes per metre (A/m) [approximately 4μT]. It is therefore unlikely that moving an existing power line will have any significant effect.

2.3.3 Any changes to the route of overhead lines will be undertaken in accordance with National Grid's environmental and planning standards and procedures.

2.4 Data collection

2.4.1 A desk-top survey of the route will be undertaken to identify any potentially sensitive sites within a 50m corridor either side of the centreline of the nearest Proposed Scheme track, or from the proposed power equipment, e.g. overhead lines and traction substations.

2.4.2 The primary sources of EMI and EMF arising from the Proposed Scheme will be the traction power distribution and overhead line electrification. The extent of any interference or harmful effects will be limited to only a short distance horizontally and vertically from the railway boundary or the boundary of any traction power substation or switching station. Whilst BS EN 50121 proposes a number of zones, in order to capture sufficient data and in

[20] National Grid (2008), Development near overhead lines - Planning and amenity aspects of high voltage electricity transmission lines and substations.

particular buildings or structures that may immediately border the >20m zone, a 50m corridor either side of the nearest rail is to be selected to identify all potential receptors within that area. Receptors outside the 50m corridor will only be considered where a significant risk is identified due to them having to a very sensitive equipment or systems.

2.4.3 The identification of possible third party receptors to EMI and EMF will be undertaken by mapping and analysing the alignment route(s) using the construction drawings for the applicable area and the route alignment maps. From this information, third party receptors that fall within the 50m corridor either side of the centreline of the nearest track and also the proposed power equipment e.g. overhead lines and traction substations will be identified.

2.4.4 Potential receptors in buildings that are to be demolished to make way for the Proposed Scheme will no longer be receptors once the Proposed Scheme is operational and are therefore not included in the assessment.

2.4.5 Although a 50m corridor has been selected, the effects of EMI can extend further afield in cases of services up to a limit of 200m and running parallel for any distance over 2km, causing induced voltages. Any such services (National Grid overhead power lines, motorway telecommunication systems, oil and gas pipelines etc.) are to be included in the data collected.

2.4.6 If construction drawings are not available i.e. individual track positions are not available, those third party receptors that fall within a 60m corridor either side of the centreline of the route will be identified.

2.4.7 An element of professional judgement must be applied whether to include receptors that fall just outside of the 50m or 60m rule.

2.4.8 Other than items identified in paragraph 2.1.1 of this technical note, any receptor outside the 50m wide corridor should not be affected and need not be considered as part of this assessment unless they contain very sensitive equipment.

2.4.9 Three types of potential receptors shall be recorded:

- locations that could contain electrical equipment that may be susceptible to EMI;
- locations where people are located that may be affected by EMF; and
- adjacent equipment that may be susceptible to induced currents for example; overhead cables, parallel telecommunications cables, pipelines or metal fencing.

2.4.10 Once each receptor has been identified, an assessment will be undertaken to categorise the perceived level of risk and to identify the potential mitigation for each receptor.

2.4.11 Preliminary traction power modelling has been undertaken by HS2 Ltd, which has identified potential electromagnetic emissions data throughout the route. This preliminary electromagnetic fields data has formed the basis for the EMI risk assessment to identify those receptors that may be at risk. The Proposed Scheme will comply with BS EN 50121 series, which limits the maximum EMF at the railway boundary.

2.4.12 Data will be collected to identify potential receptors at risk. Not all data will be presented within the ES, only those deemed to be at risk. The data collected will be kept to demonstrate an extensive search. The data will be tabulated for each type of receptor at risk, showing:

- an identification number;
- its location along the route, in kilometres;
- distance from the centre of the nearest track;
- the receptor; house, industrial unit, hospital, school etc.;
- the receptor type; industrial, residential, railway, overhead power line etc.;
- the reference that defines the immunity limit[21];
- immunity limit[22];
- estimated emission level[23];
- is there an EMI/EMF risk (yes or no);
- mitigation measures; and
- other comments.

2.4.13 From the information identified above, only significant risks will be reported in the ES. As many of the EMF/EMI risks will be mitigated through the design, installation, operation and maintenance of the Proposed Scheme, receptors at risk will be identified as part of the environmental impact assessment are:

- residential, commercial and light industrial receptors ('residential receptors') sufficiently close to the Proposed Scheme that may be susceptible to EMI. Where these are identified, they will be subject to further assessment at detailed design stage. Table 1 in Appendix A of this technical note will include EMI receptors within 20m of the centreline of the nearest track, although some of these may not be at risk due to their particular situation e.g. sufficiently below a viaduct such that the EMI is expected to be below 3 A/m;
- in exceptional cases, where receptors are sufficiently close to the Proposed Scheme such that the plots in Appendix B of this technical note do not provide sufficient resolution to conclude that there is no EMF risk to particular receptors (typically, within 10m from the centreline of the nearest track), Table 2 in Appendix A will include these receptors, which will be further assessed at detailed design stage; and

[21] This is a reference to the standards that indicate immunity limits used to evaluate the receptor.

[22] Immunity limits are the maximum Electromagnetic intensity values that can be tolerated by a receptor before degradation or harm. See tables in appendix A for specific values for equipment and human health limits.

[23] These are estimated EMF emission values according to the preliminary traction modelling results, see Appendix B of this technical note for contour plots for values.

- infrastructure identified above which runs parallel to the Proposed Scheme for over 2km and within 200m from either side of the centreline of the track. This infrastructure may be at risk of induced voltages, which can be mitigated through adherence to applicable standards at the design and installation stages. These receptors will be presented in Table 3 in Appendix A of this technical note.

2.5 Emission levels

2.5.1 The preliminary results of the traction power conducted by HS2 Ltd modelling show anticipated levels of EMF as contour plots. These plots are reproduced within Appendix B of this technical note and show key points from the centreline of the railway. They represent notional feeding sections of the Phase One route and are still relevant to the Proposed Scheme as the feeder station loads correspond to the maximum traction power supply load on the HS2 route.

2.5.2 The worst case values of EMF will be used in determining the level of risk, which will depend on the receptor location in relation to track level, i.e. in a cutting, on an embankment or viaduct, or in a tunnel.

2.5.3 In any case, the Proposed Scheme will comply with BS EN 50121, which limits the maximum EMF at the railway boundary to below ICNIRP levels.

2.5.4 Outside the railway boundary, the levels of radiated electric fields generated from the traction power will not exceed the 5kV/m threshold within the ICNIRP guidelines and will have no adverse effect on human health. It will not therefore be considered further in this assessment. This has been established from the preliminary traction power modelling.

2.5.5 Results from the preliminary modelling estimates a maximum induced voltage per unit length of approximately 30V/km at 20m from the centre of the nearest track. From this data there is therefore the potential for any electrical conductor[24] within 20m exceeding the 60V touch threshold[25] if it runs parallel to the Proposed Scheme for over 2km. Similarly, between 20m and 50m from the centre of the nearest track, there is risk of induced voltages of over 60V where parallel running is over 3km.

2.5.6 Motorways that run parallel for a significant distance, typically more than 2km and up to 500m separation, may have telecommunication lines that could be susceptible to induced voltages. The induced voltage limits for telecommunication lines are recorded in the International Telecommunication Union Directive ITU-T Volume VI[26].

[24] An electrical conductor is a material that allows electric current pass through it easily.

[25] Touch threshold is a safe voltage/current value above which electric shocks are experienced and it is typically around 60V.

[26] International Telecommunication Union, ITU-T Directives, concerning the protection of telecommunication lines against harmful effects from electric power and electrified railway lines: Volume VI Danger, damage and disturbance.

2.6 Risk assessment

2.6.1 The risk assessment will consider the following potential risks against each establishment or location:

- health immunity from the effects of power frequency magnetic fields;
- equipment immunity from the effects of radio frequency electric fields and power frequency magnetic fields; and
- effects of induced voltages and other effects.

Health immunity

2.6.2 The effects of magnetic fields will be assessed against the limits in ICNIRP for electromagnetic exposure to workers and the general public. For exposure compliance, extrapolated magnetic fields will be compared with the ICNIRP reference levels. The magnetic field levels will be taken from the contour plots that are contained within Appendix B of this technical note.

2.6.3 The plots indicate less than 10μT level of EMF at distances of between 7-10m from the centreline of the nearest track. This level is significantly lower than the 100μT ICNIRP recommendation for general public exposure.

2.6.4 ICNIRP identifies the reference level for short term exposure to magnetic fields, which are the only guidelines set by the UK Government. There are no standards applicable to long term effects. The risk arising from long-term, low level of magnetic field exposure to children is not assessed here as although ICNIRP acknowledges research in this area, it concludes that "a causal relationship between magnetic fields and childhood leukaemia has not been established nor have any other long term effects been established".

Electrical interference

2.6.5 The modelled contour plots (Appendix B of this technical note) indicate a 4A/m (equivalent to 5μT) level of emissions at approximately 15m from the centre of the nearest track. This level is above the 3A/m limit for residential immunity specified in BS EN 61000-6-1[27]. Therefore residential receptors within 20m of the centre of the nearest track are considered to be potentially at risk from EMI.

2.6.6 The 20m distance is dependent on the receptor being at the same level as the railway. If the Proposed Scheme is on a viaduct, embankment or in a cutting this would affect the level of risk and should be considered when identifying receptors at risk.

[27] British Standards Institution (2007), *BS EN 61000-6-1:2007. Electromagnetic compatibility Part 6.1: Generic standards - immunity for residential, commercial and light industrial environments.*

2.6.7 Exceeding the reference level does not necessarily mean that the prescribed basic restrictions have been exceeded. Where reference levels have been exceeded then mitigation measures will be provided. The prediction of potential interference at this point in time is based on the preliminary traction power modelling. Further models will be generated during detailed design to facilitate further assessment. In some cases, interference may not be known until the testing and commissioning stage, where further mitigation may be necessary. The preliminary modelling is based on worst case levels of generated EMF, which appear as peak levels that may be experienced for very short periods of time.

2.6.8 There may be residual effects for people with active medical implants, including pacemakers, where the EMC immunity performance of the active medical implant is less than the immunity performance specified in applicable harmonised standards.

2.6.9 The effects of EMI will be assessed against the limits in BS EN 61000-6-1 and BS EN 61000-6-2[28]. Table 4 in Appendix A summarises the limits for both magnetic and electric immunity.

Other effects

2.6.10 The effects of induced voltages are mitigated by adherence to British and European Standards as well as industry best practice throughout the design, installation, operation and maintenance phases.

2.6.11 Similarly, any effects on other railways will be mitigated through adherence to British and European Standards as well as industry best practice throughout the design, installation, operation and maintenance phases. Studies undertaken previously on similar railway projects, suggest that the risk posed by a new electrified railway is well within recommended limits and that the risk of EMI is only confined to the railway infrastructure.

Wildlife

2.6.12 The published studies as identified in the ICNIRP guidance addressing the risk of EMF to wildlife shows little or no evidence of a significant environmental impact.

2.7 Mitigation

2.7.1 Management and control of EMI will be assured by application of, and compliance with, the following standards and by adopting best practice for design, installation, maintenance and operation:

- compliance with the EU Directive 2014/30/EU and the UK Statutory Instrument Electromagnetic Compatibility Regulations 2016;

[28] British Standards Institution (2006), *BS EN 61000-6-2:2019. Electromagnetic compatibility Part 6.2: Generic standards - immunity for industrial environments.*

- application of harmonised standards BS EN 50121, BS EN 50122 and BS EN 61000 series of standards;
- comply with applicable Technical Specifications for Interoperability; and
- application guidance of Network Rail (NR) code of practice NR/L2/RSE/30041[29], which although is not applicable to the Proposed Scheme, is an example of best practice.

EMF and human health

2.7.2 It is extremely unlikely that the levels of EMF will exceed those recommended in ICNIRP; the results of modelling indicate that at distances of between 7m and 10m from the track centreline the estimated emissions are below 10% of the acceptable ICNIRP levels.

2.7.3 For public access where bridges pass over or under the Proposed Scheme, the level of EMF exposure may be higher than that at ground level, however it is unlikely to reach maximum threshold. The level of exposure is also likely to be of a transient and short term nature (e.g. crossing a bridge in a vehicle or on foot).

2.7.4 It is therefore expected that in most cases no mitigation against EMF will be required, as the ICNIRP threshold limits will not be exceeded.

2.7.5 There may be exceptional cases where receptors are sufficiently close to the Proposed Scheme such that the plots in Appendix B of this technical note do not provide sufficient resolution to conclude that there is no EMF risk to particular receptors. These receptors will be included in Table 2 and they will be further assessed at detailed design stage.

Electromagnetic interference

2.7.6 Potential mitigation to address significant EMI issues for receptors affected by the Proposed Scheme include:

- relocation of the receptor to a location where the impact is reduced below accepted limits;
- control of emissions from the Proposed Scheme;
- screening; and
- increase the immunity of the receptor (replace equipment designed for residential immunity with that designed for industrial immunity).

2.7.7 It is expected that EMI risks may only affect residential receptors within 20m from the centreline of the nearest track or industrial receptors with very sensitive electrical or electronic equipment. Where identified, these receptors will be further evaluated during the detailed design stage of the project and further mitigation applied, which may be in the form of replacement of equipment with less sensitive equipment.

[29] Network Rail (2012), *NR/L2/RSE/30041 Electromagnetic Compatibility Assurance Process*. Issue 2, dated 2 June 2012.

Induced voltages and other effects

2.7.8 In addressing the impact of the route running alongside, over or under an existing railway, mitigation will be met by meeting the requirements of both BS EN 50121 and BS EN 50122 suite of standards for design, construction, operation and maintenance. The design solutions will have to be agreed with the railway owner at the detailed design stage though consultation.

2.7.9 Induced voltages are mitigated by separation, screening or earthing and bonding. Metallic pipes and conduits that are within 60m from the railway and run parallel for more than 200m can be bonded to earth electrodes at intervals at no greater than 200m. Such solutions will be discussed with the infrastructure owner at the design stage for agreement.

2.7.10 Where there is parallel operation with an existing motorway for a significant length, typically exceeding 2km, a review is required to be undertaken at the design stage and in discussion with the motorway owner to agree mitigation in accordance with existing British and European Standards as well as industry best practice.

Construction

2.7.11 Mitigation against any specific construction issues will be addressed during the design. It will be the responsibility of the main works contractor to manage these issues on site.

2.7.12 High voltage supplies for construction machinery, especially for tunnel boring machines will comply with EMC standards and follow good engineering practice and should not emit EMF at harmful levels.

2.7.13 Construction machinery and plant, and associated communications (e.g. construction radios) will comply with the applicable standards for EMF and EMC, for example Machinery Directive 2006/42/EC[30]. Therefore when installed, operated and maintained correctly, the risk of this apparatus producing EMF exceeding published limits for workers and the public or causing EMI is considered to be low.

2.7.14 All other electrical equipment used for construction will conform to the EMC Directive and should not cause any adverse effects.

2.7.15 It is therefore expected that no mitigation against EMF or EMI will be required for construction.

2.8 Cumulative effects

2.8.1 The likely cumulative effects of the Proposed Scheme running alongside an existing railway electrified at 25kV are unknown at this point in time. The electrification design of the

[30] *Directive 2006/42/EC on machinery and amending Directive 95/16/EC 2006.* Strasbourg, European Parliament and European Council.

Proposed Scheme is not sufficiently developed to make an accurate prediction. In undertaking the assessment of likely receptors the cumulative effects have assumed to be the addition of the respective EMF strengths at any particular point from the railway. The results from the preliminary traction modelling show that the maximum level of EMF at a point 20m from the centre of the nearest track is less than 3% of the ICNIRP limit for residential receptors. It is highly unlikely that any cumulative effect will come anywhere near to the ICNIRP level and will be discounted from the assessment.

2.8.2 The cumulative level of EMI resulting from running alongside an existing electrified railway may lead to the recommended 3A/m residential limit identified in BS EN 61000-6-1:2019 being exceeded. Interference at this level is not always certain; other factors can affect the outcome. Where this occurs, individual tests can be undertaken to assess the level of interference once the Proposed Scheme is energised. For the purpose of the risk assessment, those receptors that are within 20m of centreline of the nearest track, are to be considered at risk.

2.8.3 It is unlikely that any cumulative effect will exceed the 30A/m industrial limit identified in BS EN 61000-6-2:2019 and will be discounted for this assessment.

2.9 Climate change

2.9.1 The levels of generated EMF and EMI are dependent on the traction power, which has been calculated for a worst case scenario based on the maximum number of trains running per hour. Any change in climate is unlikely to affect the output from the traction power and cause any significant increase in EMF or EMI and will be discounted for this assessment.

2.10 Significance

2.10.1 The ES must identify all likely significant effects and it is therefore necessary to describe the level of significance of the effect for each type of risk. The following sections describe the levels of significance for EMF and EMI.

2.10.2 The limit recommended by ICNIRP for short term effects of EMF exposure to the general public is 100 μT, and for occupational exposure the recommended limit is 1000μT. According to the preliminary modelling results, the maximum level of EMF estimated outside of the railway boundary is less than 10μT or 10% of the acceptable limit. The level of significance for EMF is therefore regarded as negligible.

2.10.3 The immunity level specified in BS EN 61000-6-1:2019 for electromagnetic interference to occur in residential properties is 3A/m. Any value above this is significant; however the effects of EMI on residential electrical or electronic equipment would be classed as moderate; defined as, “limited impact (by extent, duration or magnitude) which may be considered to be potentially significant”.

2.10.4 From the preliminary modelling results, only residential properties up to 20m from the centreline of the nearest track are considered to be at risk from EMI.

2.10.5 Similarly, the immunity level specified in BS EN 61000-6-2:2019 for electromagnetic interference to occur in industrial properties is 30A/m. The preliminary modelling results show that this figure is unlikely to be exceeded and therefore the significance of EMI on industrial properties is therefore regarded as negligible.

2.10.6 Where there is an impact on an existing railway, overhead power line, motorway telecommunication systems or metallic services running parallel with the Proposed Scheme, all issues will be mitigated through design, installation, operation and maintenance to current British and European Standards, as well as industry best practice. Such design solutions will be developed though consultation with the infrastructure owner. As a result, effects of EMF or EMI on these systems can be disregarded for the purpose of reporting significance in the ES.

2.11 Presentation of assessment results

2.11.1 Receptors at potential risk of EMI are to be included within the table of results, which will form part of the Volume 5 appendices of the ES. Such receptors will be limited to residential properties within 20m from the centreline of the nearest track.

2.11.2 Exceptional cases of receptors at risk of EMF will be included within the table of results.

2.11.3 Consideration will be given to the position of the receptor relative to the Proposed Scheme as this may affect the risk assessment.

2.11.4 Where the Proposed Scheme runs in a tunnel, receptors within 20m are unlikely to be affected. Similarly where the Proposed Scheme runs on a viaduct, embankment or in a cutting the level of EMI may be less than for an equivalent receptor at grade.

2.11.5 Infrastructure identified in Section 2.4 which runs parallel to the Proposed Scheme for over 2km and within 200m are to be included within the table of results.

2.11.6 Tabulated examples are shown in Table 1, Table 2 and Table 3.

Appendix A: Tables

Table 1: Example of tabulated results (for EMI receptors that are within 20m from the centre of the nearest track)

ID number	Railway chainage km + m	Distance from nearest track centre (m)	Sensitive installation	Receptor	Reference	Immunity limit (A/m)	Estimated emission level	Is there a potential EMI risk?	Mitigation measures	Comments
A1	148+250	10	School	Residential	BS EN 61000-6-1	3	>3A/m	Y	Replace with less sensitive equipment	
A2	148+550	15	Machine factory	Heavy industrial	BS EN 61000-6-2	30	<30A/m	N	N/A below recommended levels	The Proposed Scheme in cutting
A3	149+050	20	House	Residential	BS EN 61000-6-1	3	<3A/m	N	N/A below recommended levels	The Proposed Scheme on embankment
A4	149+550	15	Retail unit	Light industrial	BS EN 61000-6-1	3	>3A/m	Y	Replace with less sensitive equipment	The Proposed Scheme on embankment Undertake another review once the Proposed Scheme is operational and replace equipment only then

Table 2: Example of tabulated results (for EMI receptors that are within 10m from the centre of the nearest track)

ID number	Railway chainage km + m	Distance from nearest track centre (m)	Sensitive installation	Receptor	Reference	Immunity limit (μT)	Estimated emission level	Is there a potential EMF risk?	Mitigation measures	Comments
B1	1+250	5	Residential property	Residential	ICNIRP	100	>7.47μT	unclear	Undertake further review at design stage	The Proposed Scheme on viaduct

Table 3: Example of tabulated results (for other receptors that run parallel to the proposed scheme for over 2km and within 200m)

ID number	Railway chainage km + m	Distance from nearest track centre (m)	Sensitive installation	Receptor	Reference	Immunity limit (V)	Estimated level (V)	Is there a potential EMI risk?	Mitigation measures	Comments
C1	148+800 to 152+000	50	The Proposed Scheme runs parallel to existing Birmingham Coventry 25kV electrified railway	Railway	BS EN 50122	60 normal 645 fault	To be determined at design stage	Y	To be determined at design stage	Design solutions to be agreed with the asset owner
C2	166+300 to 168+900	50-150	Buried BP pipeline	Metal pipeline	BS EN 50443	60 normal 1000 fault	To be determined at design stage	Y	To be determined at design stage	Design solutions to be agreed with the asset owner

Table 4: Assessment limits at 50Hz, taken from ICNIRP, BS EN 61000-6-1 and BS EN 61000-6-2

Basis of limit	Units	Public limit	Occupational limit
Electric fields, limit based on public health considerations	kV/m	5	10
Magnetic fields, limit based on public health considerations	μT	100	1000

Basis of limit	Units	Public limit	Occupational limit
EMC recommendations. Magnetic interference with any electronic equipment: Residential, commercial and light industrial limits	A/m A/m	3 30	

Appendix B: EMF contour plots

The following plots have been produced from the preliminary traction power modelling undertaken by HS2 Ltd which used a theoretical feeding section for computer simulation. They show worst case values of EMF along the route of the Proposed Scheme. The data cursors indicate the magnetic flux density at distances of about 10m, 15m, 20m and 30m from the centre line of the nearest track and are measured in micro Tesla (μT). The different plots represent the train positions (traction loads) in an auto-transformer feeder section. The trains are placed 20km apart on the basis of a headway which corresponds to the interval between consecutive trains at 360kph.

Figure 1: EMF Contour Plot -Line km 17.5

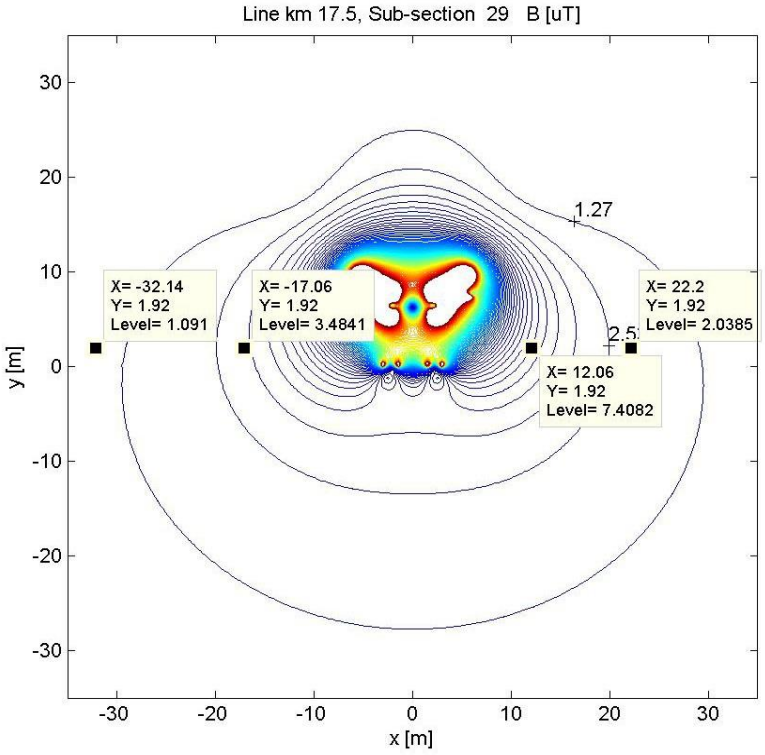


Figure 2: EMF Contour Plot -Line km 17.5

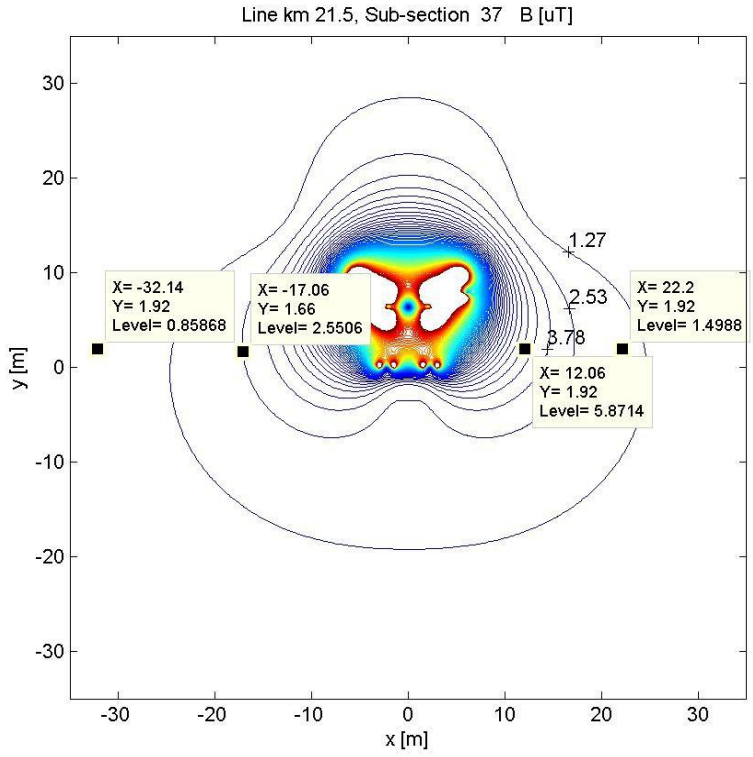


Figure 3: EMF Contour Plot -Line km 17.5

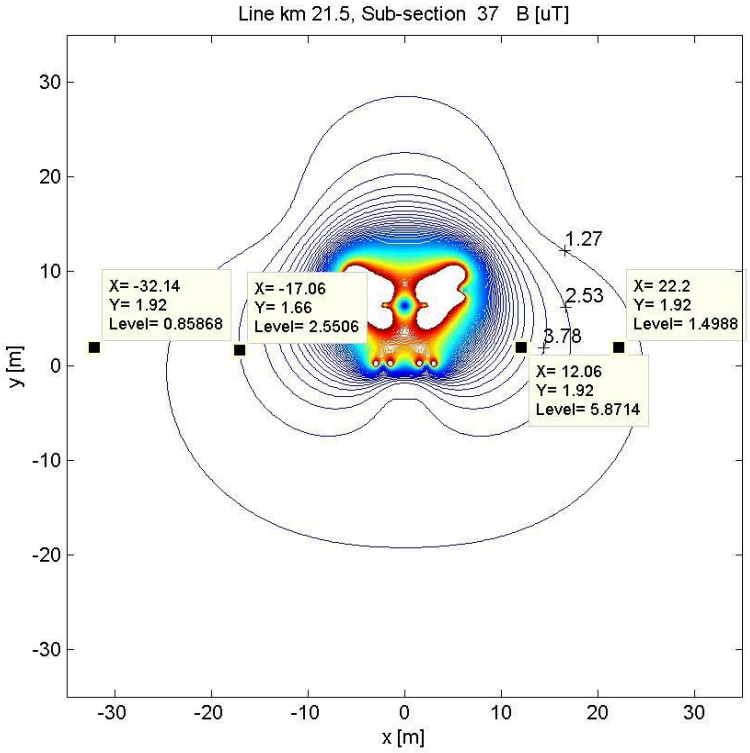


Figure 4: EMF Contour Plot -Line km 24

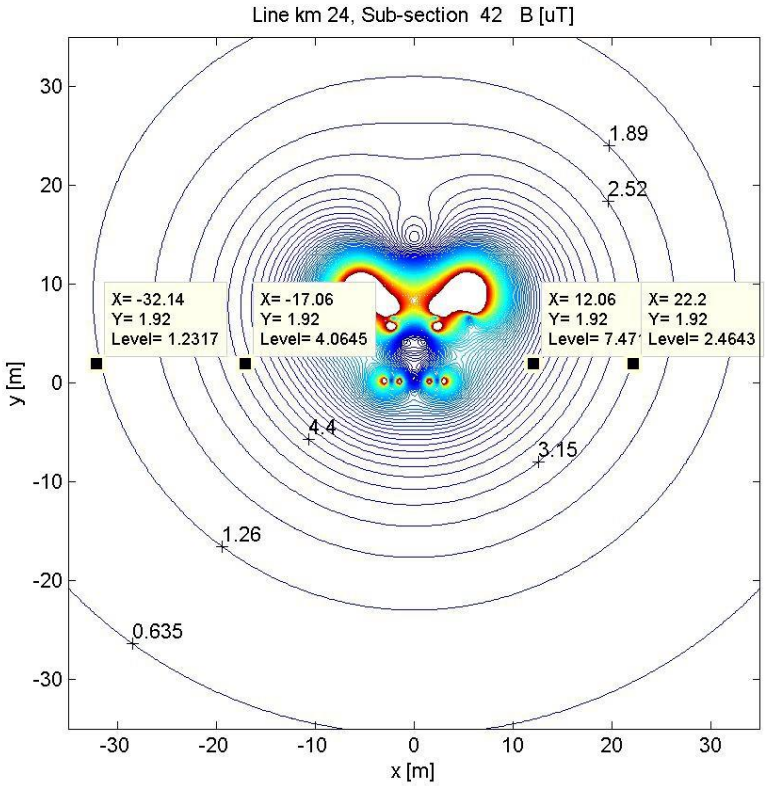


Figure 5: EMF Contour Plot -Line km 27.5

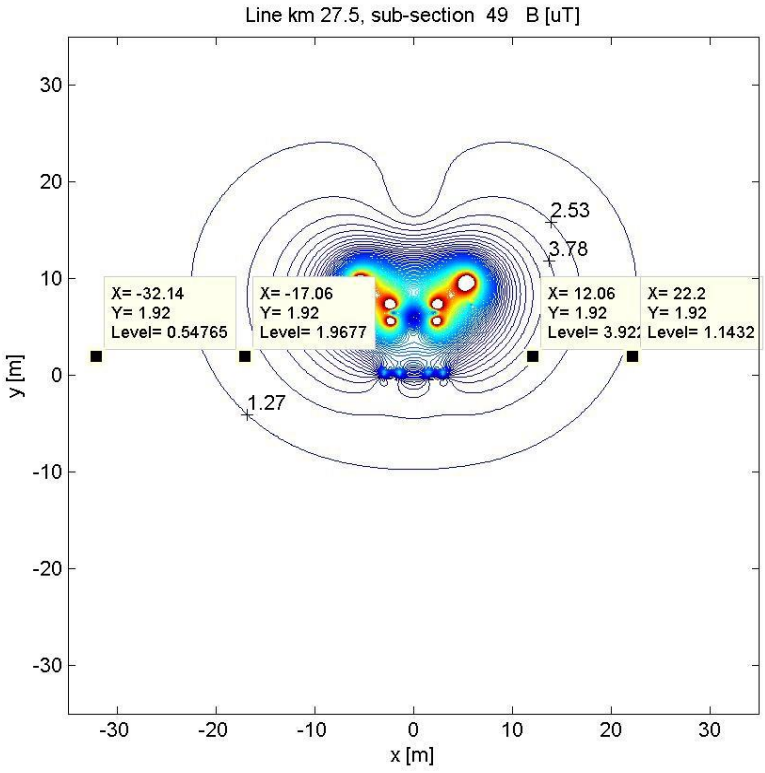


Figure 6: EMF Contour Plot -Line km 32.5

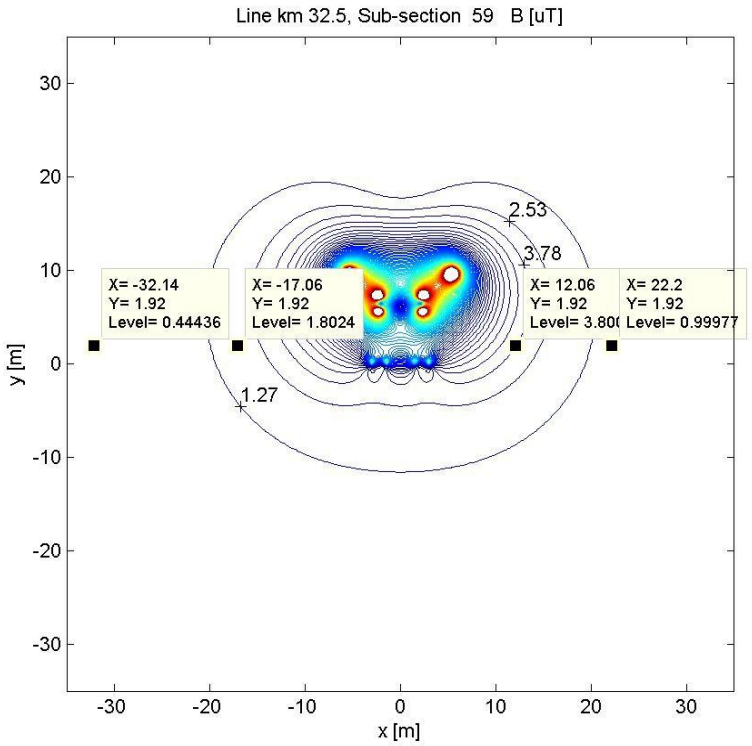


Figure 7: EMF Contour Plot -Line km 41.5

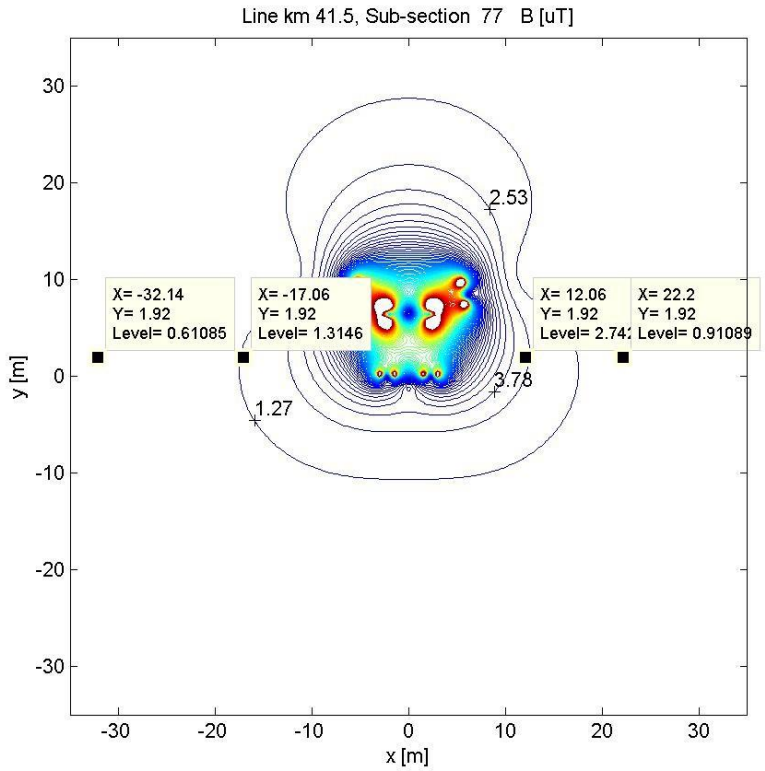
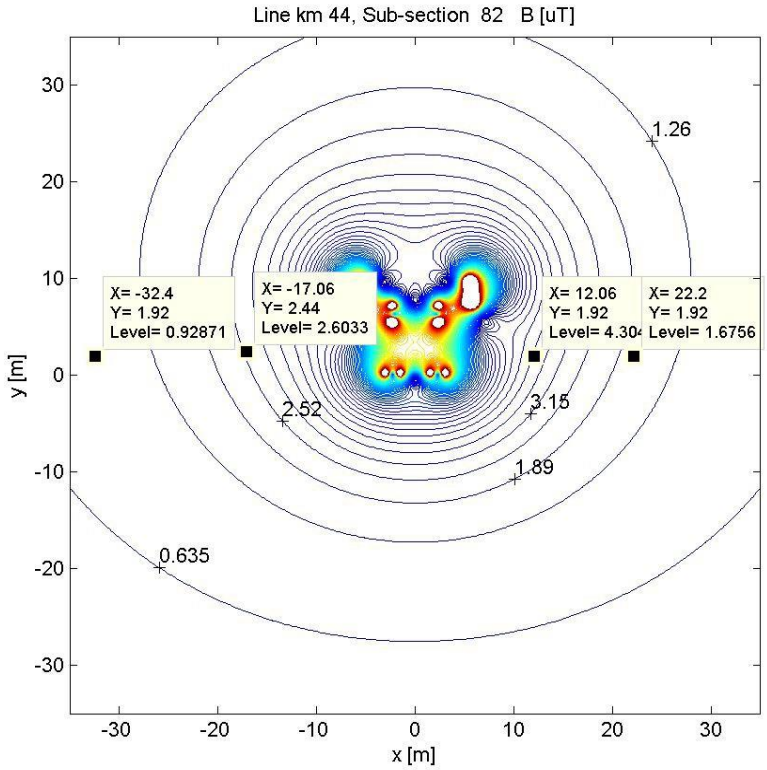


Figure 8: EMF Contour Plot -Line km 44



Annex G – Technical notes: Health

The following technical notes are contained in this annex:

- Health – Qualitative health assessment methodology;
- Health – Health assessment of social capital;
- Health – Impacts on neighbourhood quality; and
- Health – Assessing the effects of sound, noise and vibration on health and wellbeing.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Health – Qualitative health assessment methodology

Contents

1 Introduction

1.1.1 This technical note provides guidance on the qualitative assessment of potential health effects arising from the construction and operation of the Proposed Scheme. The technical note builds upon and should be read alongside the following documents:

- Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR), which provides an outline methodology for the qualitative assessment of health effects;
- Technical note: Assessing the effects of sound, noise and vibration on health and wellbeing;
- Technical note: Health assessment of social capital; and
- Technical note: Impacts on neighbourhood quality.

1.1.2 For most health determinants, the available evidence does not provide sufficient information on exposure-response relationships to enable the magnitude of health effects to be assessed quantitatively. Therefore, most of the Health assessment will be qualitative by necessity.

2 Scope of assessment

2.1.1 The assessment will not be based on a single 'study area', since the geographic extent of effects will vary between the different health determinants considered. For example, effects associated with construction traffic may occur in areas remote from the route of the Proposed Scheme, whereas effects arising from land requirements will occur within the boundaries of the Proposed Scheme.

2.1.2 Many of the health effects will be local and some will be specific to individual community areas. Other effects, however, can only be assessed at a broader, route-wide level. The Health assessment will therefore be reported both at community area level (within Volume 2: Community area reports of the Environmental Statement (ES) and at route-wide level (within Volume 3: Route-wide effects). Table 1 identifies where health determinants will be reported, i.e. at local or route-wide level.

Table 1: Health determinants assessed at local and route-wide level

Health determinant	Phase	Scope of assessment
Social capital	Construction	Community area (Volume 2)
Neighbourhood quality (local traffic, noise, dust and visual effects and perceived environmental quality	Construction and operational	Community area (Volume 2)
Access to green space, recreation and physical activity	Construction	Community area (Volume 2)
Access to services, health and social care	Construction	Community area (Volume 2)
Education	Construction	Community area (Volume 2)
Housing (relocations)	Construction	Route-wide (Volume 3)
Transport effects	Construction and operational	Route-wide (Volume 3)
Employment and income	Construction and operational	Route-wide (Volume 3)
Air quality (quantitative)	Construction	Route-wide (Volume 3)
Noise and vibration (quantitative assessment of train noise)	Operational	Route-wide (Volume 3)
Uncertainty and stress	Construction	Route-wide (Volume 3)

2.1.3 This division of the Health assessment is based on the experience gained during HS2 Phase 2a. It is not intended to be an inflexible division, however, and reasons may emerge during the assessment that justify switching the consideration of one or more determinants from Volume 3: Route-wide effects to Volume 2: Community area reports, or vice versa.

2.1.4 Where the effects on health can only be evaluated meaningfully at the route-wide level, because they apply to a population of people, then they will be reported in Volume 3: Route-wide effects. Where they only make sense at a local level, because they relate to a discrete settlement, then they will be reported in Volume 2: Community area reports.

2.1.5 Some changes brought about by construction will be permanent. In other words, the health effects may last beyond the period of construction. These impacts and effects will be reported as part of the construction section of the ES.

3 Qualitative health assessment criteria

3.1 Introduction

3.1.1 Criteria for the qualitative assessment of health effects are set out in this section. Their purpose is to ensure consistency in the assessment of potential health and wellbeing effects and to provide clear definitions for the terminology used in the assessment. The criteria are based on those used previously on Phase One and Phase 2a. That is, the HS2 Phase One Health Impact Assessment (HIA)[1], the subsequent HIA Addendum (Euston station and approach area)[2] and the Phase 2a ES.

3.1.2 There is no general consensus on what constitutes a 'significant' health effect from a development project. The Health assessment criteria will enable the potential health effects of the Proposed Scheme to be assessed without reference to 'significant'/'non-significant' effects. The intention is to identify and report those health effects that are judged to be 'consequential'. Any such effects will be reported in either Volume 2: Community area reports, or Volume 3: Route-wide effects, of the ES, with the identification of all effects set out in Volume 5: Technical appendices.

3.2 Strength of evidence

3.2.1 The strength of evidence for a link (or 'association') between an environmental or community factor (or 'health determinant') and a health outcome may be defined as:

- strong: numerous peer-reviewed research studies showing similar associations. The association is accepted by the public health community and there is consensus on the specific causal factors, the mechanism of effect and the strength of association;
- moderate: some peer-reviewed research studies showing similar associations. The association is accepted by the public health community, though there may be debate about the specific causal factors, the mechanism of effect and/or the strength of association; and
- weak: a few peer-reviewed/non-peer-reviewed research studies to suggest an association, or studies showing conflicting findings.

[1] High Speed Two Ltd (2013), *High Speed Rail (London -West Midlands), Health Impact Assessment*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378711/Health_impact_assessment.pdf.

[2] High Speed Two Ltd (2015), *High Speed Rail (London - West Midlands), Health Impact Assessment Addendum: Euston station and approach area.* Available online at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/460717/Health_impact_assessment_addendum_-_Euston_station_and_approach_area.pdf.

3.2.2 In addition, evidence may be gathered through engagement with members of the public and other stakeholders, during the assessment process, who express their opinions or describe their experiences.

3.2.3 It should be noted that weak evidence does not necessarily indicate an absence of association between a health determinant and a health outcome but shows that there is uncertainty in the assessment of the likely effect.

3.3 Nature of change

3.3.1 The nature of the change in health determinant resulting from the Proposed Scheme will be described and will include:

- the aspect of the Proposed Scheme causing the change;
- the nature of the receptor(s);
- the direction of change (beneficial or adverse);
- the perceptions of the community, which may influence the way in which people experience or react to a change; and
- the extent to which the change can be reduced or controlled, in order to minimise adverse health effects or enhance beneficial effects.

3.3.2 Professional judgement will be used in the application of the criteria on a case-by-case basis. The nature of this subject is such that it does not lend itself to a rigid and prescriptive definition that is applicable across all health determinants and all circumstances. Consequently, the criteria are intended to be a broad guide for use during the assessment process and will need to be adapted in many cases. They are to be applied with regard to the context of any given impact and to the profile of the affected population.

3.4 Duration of change

3.4.1 Operational impacts are assumed to be permanent in most cases. Construction impacts will generally be defined as 'short term' if under six months, 'medium term' if six months to two years, or 'long term' if more than two years in duration. Some consequences of construction will be permanent. Very short-term impacts, such as those lasting less than one month and occurring only once, will be scoped out in most cases.

3.5 Intensity of change

3.5.1 The intensity of the change to a health determinant will be judged as 'low', 'medium' or 'high' and will take into account factors such as the magnitude, frequency and duration of the impact and/or the value of, and how replaceable is, an affected resource(s).

3.5.2 The intensity of change may be expressed as a range (e.g. 'low to medium') to take account of the different levels of intensity experienced by different groups and individuals within the population affected.

3.6 Extent of exposure to change

3.6.1 The size of the population exposed to the change will be described as 'low', 'medium' or 'high'. The following examples provide broad guidance on how the extent of exposure will be judged in the assessment, as might be applied to an impact occurring in a Community Area.

3.6.2 'Low' extent of exposure to change:

- the change affects the occupiers of fewer than ten residential properties;
- the change affects a community resource that is used sporadically or by a small group of people; or
- the change is likely to affect only a small number of individuals within the local/wider population.

3.6.3 'Medium' extent of exposure to change:

- the change affects some tens of residential properties;
- the change affects a well-used local community resource; or
- the change affects a proportion of the local/wider population.

3.6.4 'High' extent of exposure to change:

- the change affects some hundreds of residential properties;
- the change affects a well-used community resource serving the wider population (e.g. borough or regional level); or
- the change affects a substantial proportion of the local/wider population.

3.6.5 The judgement on exposure will consider the proportion of the population exposed to a change, as well as the absolute number of people exposed. For example, for a given number of properties affected in a rural village the level of exposure may be considered 'high', whereas the same number of properties within an urban area could be 'moderate' or 'low'. In many instances, the extent to which a change will be experienced by the population cannot be accurately determined and a reasonable assumption will need to be made.

3.7 Sensitivity of the affected population

3.7.1 The sensitivity of the affected population will be considered, based on information contained in the community profile and feedback received through community engagement. This will include, where appropriate, an assessment of effects on sections of the community with particular characteristics that may make them more vulnerable to adverse effects, or more likely to benefit from positive effects.

4 Interfaces with other assessment topics

4.1.1 The Health assessment will be undertaken through an integrated assessment process, working closely with other assessment topics to share information and coordinate the assessment process. The key interfaces are shown in Table 2.

Table 2: Health assessment topic interfaces

Health topic	Other assessments						
	Equality	Community	Socio-economics	Traffic and transport	Landscape and visual assessment	Sound, noise and vibration	Air quality
Education, employment and income	✓	✓	✓				
Transport	✓	✓		✓			
Housing	✓	✓					
Social capital	✓	✓		✓			
Noise and vibration	✓					✓	
Air quality	✓						✓
Neighbourhood quality	✓	✓			✓	✓	✓
Opportunities for physical activity	✓	✓		✓			
Access to services, health and social care	✓	✓		✓			

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Health – Health assessment of social capital

Contents

1 Introduction

1.1 Purpose of this technical note

1.1.1 An assessment of health effects will be included in the the Proposed Scheme Environmental Statement (ES). This will consider how the health of the affected population may be influenced by changes to 'health determinants' (environmental, economic and social factors that can influence health) resulting from the Proposed Scheme. This technical note provides guidance on the assessment of health effects related to changes in 'social capital'. It provides a definition of social capital, describes how social capital is linked to health and describes how the effects of the Proposed Scheme will be assessed. Social capital is likely to be the health determinant most influenced by the Proposed Scheme and has the potential to give rise to the largest health effects, as measured by the number of people affected.

1.1.2 Several environmental topics will assess impacts relating to social capital, most notably Community. This technical note also describes the interface between the Health assessment and other assessments of relevance.

1.1.3 The technical note builds upon and should be read alongside:

- Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR); and
- Technical note: Qualitative health assessment methodology.

1.2 Definition of social capital

1.2.1 The term 'social capital' refers to social networks and the value of these networks to individuals and society. The concept of social capital acknowledges the contribution made by social networks in a range of areas such as health and wellbeing, educational attainment, productivity and crime rates.

1.2.2 The Office for National Statistics (ONS)[1] provides the following definition of social capital:

"In general terms, social capital represents social connections and all the benefits they generate. Social capital is also associated with civic participation, civic-minded attitudes and values which are important for people to cooperate, such as tolerance or trust."

1.2.3 The ONS identifies four main dimensions of social capital:

- civic participation: individual involvement in local and national affairs and perceptions of ability to influence them;
- social networks and support: contact with, and support from, family and friends;
- social participation: involvement in, and volunteering for, organised groups; and
- reciprocity and trust: the amount of trust individuals have in others, those they know and do not know, as well as trust in formal institutions.

[1] Office for National Statistics (2015), *Measuring national wellbeing: An analysis of social capital in the UK.*

1.3 Links to health and wellbeing

1.3.1 A review of evidence linking social capital with health outcomes was undertaken for the HS2 Phase One Health Impact Assessment[2] and the HS2 Phase 2a ES[3] and the key findings are summarised below. That literature review was updated for the as part of the supporting evidence for the Proposed Scheme.

1.3.2 Social networks are important to people's quality of life and play an important role in improving health and wellbeing. Social connections provide emotional support that can help people to cope with stressful life events. This type of support has also been shown to exert positive physiological effects on the body's hormonal and immune systems, and reduce susceptibility to mental and physical illness.

1.3.3 An evidence review undertaken by the ONS identified a range of beneficial effects associated with increased social capital including:

- improved personal wellbeing and health;
- improved integration and connectivity within communities to the benefit of their members; and
- economic benefits, for example through the value of informal care, more effective running of institutions and reduced crime rates.

[2] High Speed Two Ltd (2013), *High Speed Rail (London -West Midlands), Health Impact Assessment*. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/378711/Health_impact_assessment.pdf

[3] High Speed Two Ltd (2017), *High Speed Rail (West Midlands - Crewe), Environmental Statement.* Available online at: https://www.gov.uk/government/collections/hs2-phase-2a-environmental-statement

2 Approach to assessing social capital

2.1 Baseline

2.1.1 The levels of social capital within the existing communities along the Proposed Scheme will be evaluated using the following information:

- the density and distribution of communities and size of settlements;
- demographic information including age profile, unemployment levels, ethnic diversity and Index of Multiple Deprivation data on access to services;
- public transport links, levels of private car ownership and journey times between communities and facilities; and
- the presence of formal and informal facilities and spaces where communities meet, for example:
  - local centres where shops, post offices and banks are located;
  - community facilities such as libraries and leisure centres;
  - places of worship;
  - restaurants, pubs, cinemas, theatres etc.;
  - private members' clubs and organisations;
  - local community groups, residents' associations etc.; and
  - local parks and public spaces.

2.1.2 This information will be largely drawn from the data gathered by the community, socio-economic and transport assessments.

2.1.3 Additional information about social capital will be taken from a review of responses to consultation on the working draft ES, other engagement activities and through discussion with health sector stakeholders. This will aim to increase understanding of issues such as:

- barriers to accessing community facilities and social networks;
- levels of participation in cultural and leisure activities and membership of social groups;
- levels of community cohesion and perceived safety of neighbourhoods; and
- how well-informed people feel about local affairs (including the Proposed Scheme), levels of trust in the authorities and perceptions of their ability to influence events.

2.1.4 Social capital cannot be measured. Any commentary on baseline social capital will therefore be expressed in a qualitative manner focussing on whether social capital is likely to be 'high' or 'low'.

2.2 Assessing the Proposed Scheme's impacts on social capital

2.2.1 The assessment will identify those aspects of the Proposed Scheme that have the potential to increase or reduce levels of social capital, either permanently or temporarily, and will examine the potential pathways through which these impacts may occur.

2.2.2 Aspects of the Proposed Scheme with the potential to affect social capital will include:

- removal of people from the community through residential relocations;
- impacts on community facilities and spaces that support social capital through demolition/partial removal/relocation of community facilities, parks etc.;
- impacts on the amenity value of community facilities and spaces that support social capital due to proximity to construction activities or the operation of the Proposed Scheme;
- effects on movement within and between communities due to road and footpath closures and diversions; and
- introduction of new people into the community e.g. the construction workforce.

2.2.3 The Health assessment will identify the potential social capital impacts on the people directly affected by these changes and on the community as a whole.

2.2.4 Individual impacts that, when combined, could lead to changes in social capital will be assessed for each community area and, where relevant, for specific settlements or defined areas within community areas. The assessment will consider whether the Proposed Scheme has the potential to affect levels of social capital in the community by:

- changing the availability, accessibility and/or attractiveness of places in which people meet and socialise;
- affecting levels of participation in cultural and leisure activities and membership of social groups;
- affecting people's ability to travel to visit friends and family;
- changing levels of community cohesion, trust and perceived safety of neighbourhoods; and/or
- influencing the demographic profile of the community.

2.3 Assessing health effects

2.3.1 The assessment of health effects associated with changes in social capital will be qualitative. Where a likely impact on social capital is identified, it is considered that there would be a corresponding effect on health and wellbeing across the affected population (but not necessarily for individuals). This is based upon evidence showing associations between levels

of social capital and health and wellbeing (to be reported in the Route-wide commentary on health evidence base in ES Volume 5 technical appendices).

2.3.2 Other environmental topics will assess the impacts of the Proposed Scheme on the physical environment and socio-economic conditions in the study area, using numerical criteria (e.g. number of properties demolished) to identify significant effects. The Health assessment will use reasoned judgement to assess the potential effects on social capital and consequent effects on health and wellbeing at a population level, as they relate to discrete settlements and communities.

2.3.3 The potential for health effects to occur from impacts to social capital will be assessed using the criteria set out in the Technical Note: Qualitative health assessment methodology.

2.3.4 It will be difficult to assign specific health outcomes to any impacts on social capital that are identified. The evidence base in published literature relating to social capital reports associations with a wide range of health outcomes, including premature mortality. In practice, and for this assessment, it is reasonable to restrict the reported health effects to a change in wellbeing status for some of the affected population. This does not preclude the existence of more severe health outcomes, but these cannot be predicted with sufficient confidence.

2.4 Relationship with other topic assessments

2.4.1 Impacts of the Proposed Scheme that have the potential to influence social capital will be assessed within other sections of the ES, including Community, Landscape and visual, Socio-economics, Sound, noise and vibration and Traffic and transport. Information will be obtained through discussion with other environmental topic teams during the assessment process. This interaction is crucial to the identification of impacts on social capital that might otherwise go unreported, since the other environmental topics do not report impacts on social capital directly. There is no formal methodology for the inclusion of relevant impacts identified in other topics; instead it will be for the health effects team to draw out, through discussion, the relevant features of the Proposed Scheme and the associated impacts on the components of social capital.

2.4.2 The Health and Community assessments will both use information from the Landscape and visual; Sound, noise and vibration; and Traffic and transport assessments. The Community assessment will identify the in-combination effects on community resources and receptors associated with the significant effects from other environmental topics. The Health assessment, on the other hand, will identify the potential impacts on social capital arising from the impacts pertinent to other topics that may be present at levels that do not result in a 'significant effect' being reported in a given environmental topic. This will include the effects of perceptions about the potential impacts of the Proposed Scheme.

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Health – Impacts on neighbourhood quality

Contents

1 Introduction

1.1.1 An assessment of health effects will be included in the Environmental Statement (ES). This will consider how the health of any affected population may be influenced by changes to 'health determinants' (environmental, economic and social factors that can influence health) resulting from the Proposed Scheme.

1.1.2 This technical note provides guidance on the assessment of health effects arising from changes in a health determinant that is given the term 'neighbourhood quality'. This term refers to aspects of the physical environment that, in combination, influence the way in which people 'feel' about the place they live; how it looks, how safe it feels and the presence of any annoyances that affect daily life.

1.1.3 The evidence base supporting the assessment (Route-wide commentary on health evidence base, Volume 5: Technical appendices) will include a section on neighbourhood quality and will summarise the evidence linking peoples' views on their surroundings with health status. The general point to be made is that living in surroundings that look good, feel safe and are free of annoyances will improve mental health, just as the converse is true.

1.1.4 The technical note builds upon and should be read alongside the following documents:

- Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR);
- Technical note: Qualitative health assessment methodology; and
- Technical note: Assessing the effects of sound, noise and vibration on health and wellbeing.

2 Approach to assessing neighbourhood quality

2.1 Interface with environmental topics

2.1.1 Other topics assess some of the environmental impacts that relate to neighbourhood quality, including traffic and transport, landscape and visual, sound, noise and vibration, and air quality. The other factor is aspects of the physical environment included in the neighbourhood quality assessment is physical changes that may affect perceptions of safety and security; this is not assessed directly by other topics.

2.1.2 The environmental topics will use defined significance criteria to identify receptors, or groups of receptors, that will be subject to significant effects. The health assessment is concerned with effects on population health and wellbeing resulting from changes to the overall physical quality of a neighbourhood. This approach is distinct from topics that assess effects at receptor level. Therefore, while the health assessment will draw on the findings of the environmental topics, the conclusions of the neighbourhood quality assessment will not always correlate with these topics.

2.1.3 In addition to affecting how people feel about the quality of their living environment, changes in the level of exposure to noise and air emissions across a large population can have a measurable effect on specific physical health outcomes. These types of effect do not form part of the neighbourhood quality assessment. The methodology for assessing these effects is set out in the Technical Note: Assessing the effects of sound, noise and vibration on health and wellbeing.

2.2 Scope and definitions

Scope of neighbourhood quality assessment

2.2.1 A neighbourhood quality effect will occur when it is considered that there will be noticeable (negative or positive) changes in the public realm to two or more of the following aspects:

- landscape character and/or visual impacts;
- traffic flows, including heavy goods vehicles (HGV);
- ambient noise;
- dust and odour; and
- perceived safety and security.

2.2.2 Based on mitigation included in the draft Code of Construction Practice, it is considered unlikely that any nuisance effects will arise as a result of dust and odour. Therefore, there will be a presumption to scope out this effect from the neighbourhood quality assessment, unless there are exceptional reasons for including it.

2.2.3 Based on the predicted traffic impacts in the operational phase, operational traffic flows are scoped out of the assessment.

2.2.4 The minimum duration for identifying a neighbourhood quality effect during construction is six months. Operational impacts are considered to be permanent.

Public realm

2.2.5 For the neighbourhood quality assessment, the term 'public realm' refers to the following areas:

- residential streets;
- high streets and shopping areas;
- public footpaths and circulation space around community facilities;
- public spaces such as village greens, public squares etc.;
- parks and public gardens; and
- playing fields.

2.2.6 The following features are excluded from the definition of public realm:

- residential properties (including gardens);
- other private properties such as care homes;
- rural public rights of way; and
- highways.

Noticeable changes

2.2.7 Noticeable changes affecting neighbourhood quality will not correlate with the significant effects identified in the environmental topic assessments. This is because many significant effects will relate to residential properties and features excluded from the neighbourhood quality, whereas areas of public realm may not be identified as sensitive receptors in these assessments. However, the location of significant effects will be used as a guide to where noticeable changes are likely to occur.

2.2.8 The assessment should identify noticeable changes to the physical environment in areas of public realm and make a judgement on the likely health effects based on the scale of change, and the number of people who will experience the change. Not all noticeable changes will lead to health effects (see 2.3 below).

2.2.9 Guidance on identifying noticeable changes is provided below.

Ambient noise

2.2.10 Noticeable changes in the noise environment will not always correlate with significant effects in the sound, noise and vibration assessment, since some areas of public realm will not be identified or assessed as sensitive receptors. The sound, noise and vibration assessment will

assess significance for residential and some non-residential receptors. Sound, noise and vibration will also provide assessment data for a number of additional non-residential receptors identified by other topics such as Community (for example: for community facilities; footpaths; retail/leisure facilities etc.) but will not assign significance to these assessments. These additional sound, noise and vibration data will also inform the neighbourhood quality for the assessment of ambient noise.

2.2.11 A noticeable change in noise in terms of neighbourhood quality may be identified:

- where the sound, noise and vibration assessment identifies a significant noise effect for a residential or non-residential receptor; or
- where there is a change of +/-3dB (day or night) change in noise exposure for an additional non-residential receptor within an area; and
- where the receptor is in proximity to, or forms part of, an area of public realm as described in 2.2.5 above.

2.2.12 The term 'noticeable' effect in the Volume 2 community area reports of the ES should be mentioned specifically in relation to the receptor that was assessed within an area. Once identified, these noticeable changes in noise will be discussed and confirmed with sound, noise and vibration teams through workshops.

Landscape and visual

2.2.13 Noticeable changes in the landscape and visual environment will not always correlate with significant effects in the landscape and visual assessment, since this assessment will pick up effects on private property that are not relevant to the neighbourhood quality assessment.

2.2.14 The landscape and visual assessment will assess significance for seven types of visual receptors. Some of these, such as recreational areas and transport, form part of the public realm. Additionally, the landscape character assessment will identify significant impacts on settlements and residential districts, taking into account factors such as cultural, social and heritage value and aesthetic, perceptual and experiential qualities. A noticeable landscape and visual change, in terms of neighbourhood quality, may be identified:

- where the landscape and visual assessment identifies a significant visual effect on a receptor that forms part of the public realm, such as a transport route or recreational area; or
- where the landscape and visual assessment identifies a significant effect on landscape character in an area of public realm.

Traffic

2.2.15 A noticeable change in traffic will occur where the traffic and transport assessment identifies a significant (minor/moderate/major) increase in traffic flows, including HGV, on residential streets, high streets, or adjacent to areas of public realm as defined above. (Note: minor effects are considered as significant in the traffic and transport assessment).

Perceived safety and security

2.2.16 A noticeable change in perceived personal safety may occur where there is a reduction in the level of passive surveillance or changes to visibility and openness. The introduction of features known to be perceived as unsafe, such as underpasses, in residential neighbourhoods will also result in a change. This aspect will be based on case-by-case judgement.

2.3 Assessing health outcomes

2.3.1 Based on professional judgement, in discussion with the relevant topic specialists, the assessment teams will identify whether the components of neighbourhood quality are likely to be sufficiently influenced by the Proposed Scheme such that they will change the way people 'feel' about the place they live; how it looks, how safe it feels and the presence of any annoyances that affect daily life. The assessment process will take into account the factors described in the qualitative assessment technical note, i.e. intensity, duration and extent of the exposure to change.

2.3.2 Where an impact on neighbourhood quality is judged to be likely, either negatively or positively, this will have an effect on the wellbeing of part of the affected population. Beyond this conclusion on a change in wellbeing, it will be difficult to reach a conclusion on health outcomes that is more specific. Such a change could, if sufficiently large and occurring for a large enough population, lead to defined mental health effects, such as anxiety. It may be possible to draw this conclusion in some circumstances, but not necessarily in all.

2.4 Pro forma for neighbourhood quality assessment

2.4.1 The following pro forma should be used to record the judgements made in the assessment of neighbourhood quality. This will facilitate discussions with the relevant environment topic specialists and allow the judgements to be moderated across the assessment teams.

Community area: CA [number]

Location, (with reference to communities described in the health assessment 'Existing baseline' section)

[Description]

Noticeable changes – tick those that apply

Public realm areas	Noticeable change during construction (> 6 months duration)				Noticeable change during operation		
	Ambient noise	Landscape and visual	Traffic	Perceived safety	Ambient noise	Landscape and visual	Perceived safety
Residential streets							
High street/shopping areas							
Public circulation areas							
Public spaces such as squares, village greens							
Parks/public gardens							
Playing fields							
Other (describe)							

Qualitative description of changes during construction

Ambient noise	
Landscape and visual	
Traffic	
Perceived safety	

Qualitative description of changes during operation

Ambient noise	
Landscape and visual	
Perceived safety	

Environmental Impact Assessment Scope and Methodology Report Part 2: Technical note – Health – Assessing the effects of sound, noise and vibration on health and wellbeing

Contents

1 Introduction

1.1.1 This technical note provides information on the assessment of health effects arising from sound, noise and vibration during the construction and operation of the Proposed Scheme.

1.1.2 The technical note should be read alongside the following documents:

- Environmental Impact Assessment (EIA) Scope and Methodology Report (SMR), which provides an outline methodology for the quantitative assessment of health effects in relation to HS2;
- Technical note: Impacts on neighbourhood quality;
- Technical note: Qualitative health assessment methodology; and
- TAG Unit A3 – environmental impact appraisal[1].

[1] Department for Transport (2015), *TAG unit A3 environmental impact appraisal*. https://www.gov.uk/government/publications/webtag-tag-unit-a3-environmental-impact-appraisal-december-2015.

2 Health evidence base

2.1.1 Health and wellbeing effects caused by sound, noise and vibration from the construction and operation of the Proposed Scheme will be assessed in the Environmental Statement (ES). Evidence shows that exposure to noise and/or vibration has an effect on health and wellbeing. The assessment criteria in the sound, noise and vibration assessment are used to determine the effect that noise and vibration from the Proposed Scheme has on health and wellbeing.

2.1.2 The evidence base for the health and wellbeing assessment will be set out in the ES. This will include consideration of the following effects:

- amenity – including sleep disturbance and annoyance; and
- health – including heart attacks, strokes and dementia.

3 Approach to sound, noise and vibration assessment

3.1.1 In this assessment 'sound' is used to describe the acoustic conditions that people experience as a part of their everyday lives. The assessment considers how those conditions may change through time and how sound levels and the acoustic character of community areas is likely to be modified through the introduction of the Proposed Scheme. Noise is taken as unwanted sound and hence adverse effects are termed noise effects rather than sound effects, and mitigation is, for example, termed 'noise' barriers.

3.2 Receptor-level assessment

3.2.1 A receptor-level assessment will be reported in the Sound, noise and vibration section of Volume 2 of the ES. The spatial scope of the sound, noise and vibration study area will be defined using the assessment criteria in the SMR. The receptor-level assessment will use significance criteria to assess the impact of airborne noise effects on residential properties and other noise sensitive receptors along the route. LOAEL and SOAEL[2] thresholds are set for receptors, based on evidence linking noise exposure with observable effects on health and quality of life. The LOAEL and SOAEL values for the assessment will be informed by:

- the health evidence reviewed;
- any unique features of the Proposed Scheme's sound or impacts in the area being considered; and
- the UK Noise Insulation Regulations[3] and World Health Organization (WHO) guidelines.

[2] Lowest Observed Adverse Effect Levels and Significant Observed Adverse Effect Levels.

[3] *The Noise Insulation (Railways and Other Guided Transport Systems) Regulations 1996.* Her Majesty's Stationery Office, London.

3.2.2 This approach is consistent with HS2 Phase One[4] and Phase 2a ES[5] and HS2 Information Papers for both Phase One and Phase 2a[6] [7]. This is also aligned with Government policy aims.

3.2.3 The significance criteria for non-residential receptors are based on WHO guidelines, guidelines developed for the design of good buildings as well as levels set by previous hybrid Bill projects including HS2 Phases One and 2a, HS1, and Crossrail.

[4] High Speed Two Ltd (2013), High Speed Rail (London – West Midlands), *Environmental Statement, Volume 1: Introduction to the Environmental Statement and the Proposed Scheme*. Available online at: https://www.gov.uk/government/publications/hs2-phase-one-environmental-statement-volume-1-introduction-to-the-environmental-statement.

[5] High Speed Two Ltd (2017), High Speed Rail (West Midlands – Crewe), *Environmental Statement, Volume 1: Introduction and methodology.* Available online at: https://www.gov.uk/government/publications/hs2-phase-2a-environmental-statement-volume-1-introduction-and-methodology.

[6] High Speed Two Ltd (2014), *High Speed Two Phase One Information Paper, E20: Control of airborne noise from altered roads and the operational railway.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672395/E20_-_Control_of_Airborne_Noise_v1.5.pdf.

[7] High Speed Two Ltd (2017), *High Speed Two Phase 2a Information Paper, E9: Control of Airborne noise.* Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/960724/E9_Control_of_Airborne_Noise_v1.1.pdf.

4 Approach to health assessment

4.1 Community-level assessment

4.1.1 Quantitative data from the sound, noise and vibration assessment will be used to inform a qualitative assessment of the effects on neighbourhood quality. This assessment will consider impacts on a range of environmental factors, including from noise and vibration, affecting quality of life in communities along the route. This will be reported in the Health section of Volume 2 of the ES and will signpost the reader to the relevant information within the Sound, noise and vibration sections in Volume 2.

4.2 Population-level assessment

4.2.1 A population-level assessment of the effects of operational railway noise will be undertaken using Defra guidance[8] and reported in the Health section of Volume 3 of the ES. This assessment will quantify the expected number of people affected and then value this impact in terms of Disability-Adjusted Life Years (DALYs). This value is comprised of consideration of a number of health components over a 60-year appraisal period:

- amenity (annoyance);
- sleep disturbance;
- acute myocardial infarction (AMI);
- stroke; and
- dementia.

4.2.2 The population-level sound, noise and vibration assessment will quantify the health and wellbeing effects of noise and combine these to give an estimate of the total number of DALYs currently lost due to environmental noise and the additional DALYS associated with the entire Proposed Scheme. The percentage increase in DALYs will also be reported. A summary of this data will also be given for each component health effect. Consideration will be given to incorporating Lmax metrics into the assessment of DALYs, which currently uses following noise metrics: $L_{Aeq,16h}$ and L_{night}.

4.2.3 Table 1 below shows how the effects of sound, noise and vibration on health and wellbeing will be reported in the ES. The receptor based assessment will be reported in the Sound, noise and vibration section of Volume 2; the community and population level assessment will be reported in the Health section of Volume 3. This includes both qualitative and quantitative assessment of effects during the construction and operational phases.

[8] Department for Environment, Food and Rural Affairs (2014), *Environmental Noise: Valuing impacts on: sleep disturbance, annoyance, hypertension, productivity and quiet.* Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/380852/environmental-noise-valuing-imapcts-PB14227.pdf.

Table 1: Reporting health and wellbeing effects of sound, noise and vibration in the ES

Receptors	Period of impact	Assessment criteria or methodology	Wellbeing effects	Reporting		
				Sound, noise and vibration (Volume 2 of the ES)	Health (Volume 2 of the ES)	Health (Volume 3 of the ES)
Residential properties	Construction and operational	SOAEL/LOAEL	Significant effect on health and wellbeing at receptor	✓		
Noise sensitive non-residential properties	Construction and operational	Impact levels	Significant effect on health and wellbeing at receptor	✓		
Population level – community wide effects	Construction and operational	Neighbourhood quality – qualitative assessment of combined environmental effects	Quality of life and wellbeing		✓	
Population level – route wide residential properties	Operational	Defra guidance - DALYs over a 60-year period: – Total DALYs – Additional DALYs attributable to scheme – % increase in DALYs	Health effects broken down into: – amenity – sleep disturbance – AMI – stroke – dementia			✓

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