E139

High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices

CA4: Whitmore Heath to Madeley

Agriculture, forestry and soils data (AG-001-004)

July 2017

ES 3.5.2.4.1

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1 Introduction

1.1.1 This document is the agriculture, forestry and soils assessment Appendix for the Whitmore Heath to Madeley community area (CA4), and comprises:

- soils and agricultural land classification surveys (Section 2);
- forestry (Section 3); and
- farm impact assessment summaries (Section 4).

1.1.2 Maps referred to throughout this Agriculture, forestry and soils Appendix are contained in the Volume 5, Agriculture, Forestry and Soils Map Book.

2 Soils and agricultural land classification surveys

2.1 Background

2.1.1 The soils and agricultural baseline conditions reported have been established from desktop studies and site surveys.

2.1.2 Information gathered by desktop studies has related primarily to the identification of soil resources in the study area, the associated physical characteristics of geology, topography and climate which underpin the assessment of agricultural land quality, and the disposition of land uses. The main sources of information have included:

- National Soil Map;[1]
- Soils and Their Use in Midland and Western England;[2]
- solid and superficial deposits from the Geology of Britain viewer;[3]
- Gridpoint meteorological data for Agricultural Land Classification of England and Wales;[4]
- Provisional Agricultural Land Classification of England and Wales (1:250,000);[5]
- Likelihood of Best and Most Versatile Agricultural Land (1:250,000);[6]
- agri-environment schemes;[7]
- aerial photography from Google Earth; and
- on-site soil and Agricultural Land Classification surveys.

2.1.3 Information gathered by field survey has related to the enhancement of desk-based information on soils and agricultural land quality, and the engagement with landowners and tenants to establish the nature and extent of agricultural, forestry and related rural enterprises.

2.1.4 Where the collection of agricultural site information has enabled a review/refinement of published information, this was undertaken in accordance the methodology prescribed by Ministry of Agriculture, Fisheries and Food (MAFF)[8].

2.1.5 Information obtained from farm impact assessment interview surveys has been taken as a factual representation of local agricultural and forestry interests and has not been subject to further verification.

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[1] Cranfield University (2001), *The National Soil Map of England and Wales 1:250,000 scale*. Cranfield University: National Soil Resources Institute
[2] Soil Survey of England and Wales (1984), *Soils and Their Use in Midland and Western England*. Harpenden
[3] British Geological Survey. www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html
[4] Meteorological Office (1989), *Gridpoint Meteorological data for Agricultural Land Classification of England and Wales and other Climatological Investigations*
[5] Ministry of Agriculture, Fisheries and Food (1983), *Agricultural Land Classification of England and Wales (1:250,000)*
[6] Department for Environment, Food and Rural Affairs (2005), *Likelihood of Best and Most Versatile Agricultural Land (1:250,000)*
[7] Multi-Agency Geographical Information for the Countryside (MAGIC). www.magic.gov.uk
[8] Ministry of Agriculture, Fisheries and Food (1988), *Agricultural Land Classification of England and Wales – Revised guidelines and criteria for grading the quality of agricultural land*

2.2 Soils and land resources

2.2.1 This part of the technical appendix describes the findings of a desktop study and targeted soil survey and Agricultural Land Classification (ALC) survey that identified existing soil and agricultural land resources in the study area.

2.2.2 The location and extent of different soil types and agricultural land in the different ALC grades are influenced by topography and drainage, and by geology and soil parent materials, which are described in turn in the following sections. This section then provides a description and distribution of the main soil types encountered within the study area.

2.3 Topography and drainage

2.3.1 Topography in the area has been influenced by the actions of the River Lea on the underlying sandstone. The river has cut a broad valley floor to the south of Madeley and a more incised valley as it runs north to Wrinehill. The sandstone plateau is around 165m to 170m above Ordnance Datum (AOD), with steep valley sides to the River Lea, the Meece Brook and the Checkley Brook. The floor of the River Lea valley is around 120m AOD in the south of the area, falling to 80m AOD in the north at Wrinehill.

2.3.2 Drainage of the land is via three significant water courses: River Lea, Meece Brook and Checkley Brook. Meece Brook is the most southerly and extends south ward from Whitmore. The River Lea flows northward from west of Whitmore Heath to the north-west of Madeley. Checkley Brook is aligned roughly east to west, falling westward to the south of Wrinehill.

2.4 Geology and soil parent materials

2.4.1 In the south of the area, the route passes through early-Triassic sandstones of the Wilmslow Sandstone and Kidderminster Formations. To the north-west of Whitmore Heath, the sandstones border on Permian mudstone of the Salop Formation which continues to the west of Hey Sprink, from where the basal bedrock is dominated by sandstones and mudstones of the Halesowen Formation.

2.4.2 A pebbly sandstone outcrop of the Chester Formation is to the west of Madeley and is of Triassic age, which then borders Sidmouth Mudstone further west and north.

2.4.3 A list of geological strata occurring within the study area is provided in age order in Table 1 and shown on Map WR-02-204 (Volume 5, Water resources and flood risk Map Book).

Table 1: Bedrock and soil forming materials

Formation	Composition/soil parent material
Halesowen	Micaceous sandstone with mudstone, thin coals and limestone beds.
Salop	Mudstone, and sandstone with beds of pebbly sandstone and conglomerate.
Wilmslow Sandstone (Wildmoor Sandstone Member)	Fine- to medium-grained sandstone, generally pebble-free.
Kidderminster	Pebble conglomerate and reddish-brown sandstone.

Formation	Composition/soil parent material
Chester	Fine- to coarse-grained sandstone, commonly pebbly.
Sidmouth Mudstone	Mudstone and siltstone.

2.4.4 The Proposed Scheme passes through the following superficial deposits:

- alluvium, associated with the three water courses and comprising predominantly silty clay, but also with silt, sand, peat and gravel;
- a limited area of River Terrace Deposits to the south of Whitmore, comprising sand and gravel;
- peat deposits within the Lea Valley to the west of Whitmore Heath and Whitmore Wood;
- glacial till deposits on the lower slopes of the Lea Valley extending north-west of Whitmore Heath. These deposits include a range of unsorted material ranging in size from clay to boulders; and
- in the north of the area, glaciofluvial till deposits comprising sand and gravel.

2.5 Description and distribution of soil types

2.5.1 The characteristics of the soils are described by the Soil Survey of England and Wales bulletin that accompanies the National Soil Map. The soils are grouped into soil associations of a range of soil types (soil series) and are summarised in Table 2 and their distribution is shown on Map AG-02-104 (Volume 5, Agriculture, forestry and soils Map Book).

Table 2: Soil associations

Soil associationg: code shown on map AG-02-104	Soil association: name	Description	Wetness class[10]
541r	Wick 1	Deep well drained sandy loam and sandy soils, locally over gravel; some similar soils affected by groundwater	I-II
551a	Bridgnorth	Well drained reddish brown loamy sand over sand, with sandstone at moderate depth.	I
572c	Hodnet	Reddish clay loam and sandy loam soils with slowly permeable subsoils and slight seasonal waterlogging; some similar well drained reddish clay loam soils	II
572f	Whimple 3	Reddish clay loam and silty clay loam over clayey soils with slowly permeable subsoils and slight seasonal waterlogging; some similar clayey soils on brows; slowly permeable seasonally waterlogged clay loam over clayey soils on lower slopes	II-III

[9] Cranfield University (2017), http://www.landis.org.uk/data/nsi.cfm
[10] The Wetness Class (WC) of a soil is classified according to the depth and duration of waterlogging in the soil profile and has six categories from WC I which is well drained to WC VI which is very poorly drained

Soil associationg: code shown on map AG-02-104	Soil association: name	Description	Wetness class[10]
631e	Goldstone	Typically very acid and very stony profiles of sandy loam overlying sandstone at moderate depth. They form distinctive flat-topped hills and are predominantly under woodland or semi-natural heath.	I
711b	Brockhurst 1	Slowly permeable seasonally waterlogged reddish clay loam over clayey, with some similar soils with slowly permeable subsoils and slight seasonal waterlogging	III-IV
711n	Clifton	Slowly permeable, seasonally waterlogged clay loam and sandy clay loam.	IV
1022a	Altcar 1	Black humified or loamy peat over semi-fibrous peat lower horizons and humose clay loam or sandy loam at depth. In most areas, groundwater levels have been lowered and the soils are well drained, though with no drainage measures may be almost permanently waterlogged.	I-VI

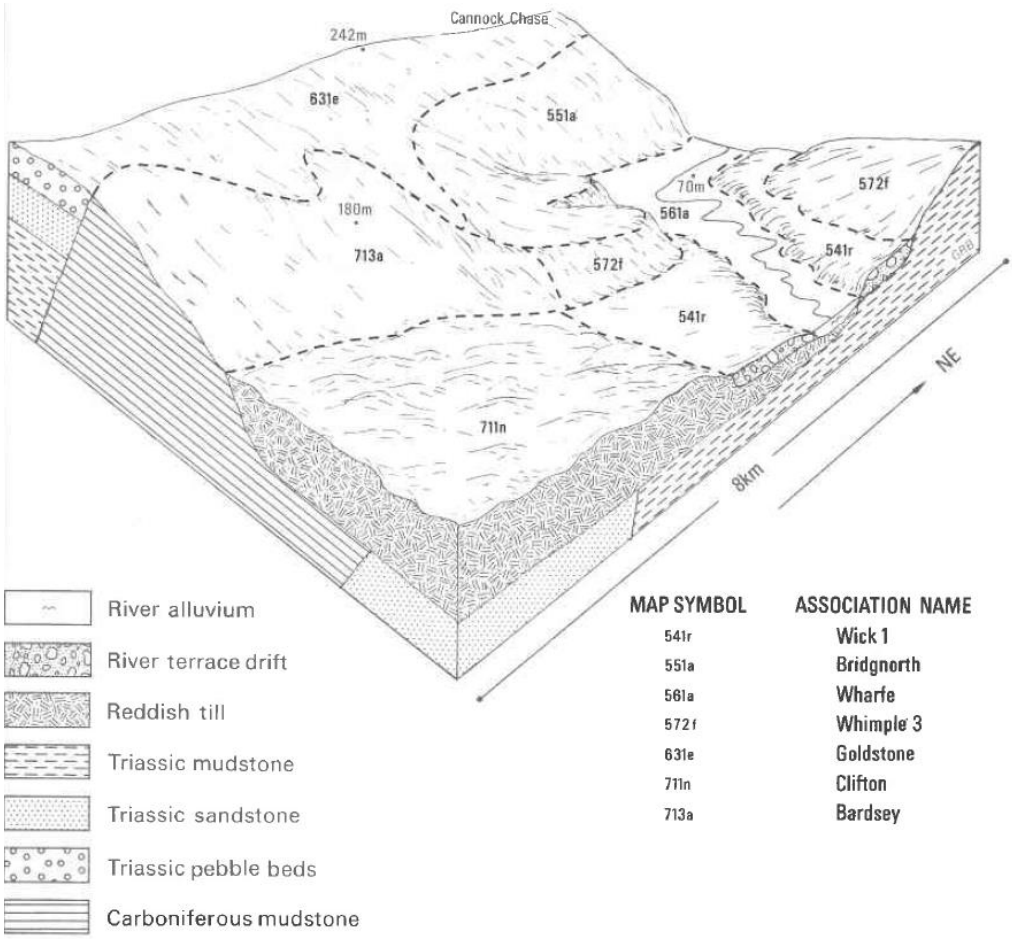
2.5.2 The National Soil Map shows the following eight soil associations in the study area:

- to the east and west of Whitmore and extending north to Madeley, the Bridgnorth association is widespread and characterised by loamy sand upper horizons over sand, passing to sandstone at moderate depth. These soils are developed in soft sandstone, predominantly on gentle to moderate slopes;
- cutting through the Bridgnorth association and broadly following the Lea Valley, are the organic peaty soils of the Altcar 1 association. Depending upon local drainage measures, Altcar 1 soils range from well drained to severely waterlogged;
- across higher altitude plateaux and moderate slopes to the east and west of the valley, at Whitmore Heath and the Maer Hills respectively, is the Goldstone association. Developed in pebbly sandstones, profiles are mostly of sandy loam. The soils are well drained but very acidic;
- on the slopes of the Lea Valley, north of Whitmore Wood and extending to Hey Sprink, and on moderate slopes north-west of Madeley, is the Whimple 3 association, developed in thin drift over mudstone. Whimple 3 soils consist of reddish loams over slowly permeable clayey lower subsoils, with slight to moderate seasonal waterlogging;
- beyond the Whimple 3 soils to the east, occupying shallower slopes is the Brockhurst 1 association, characterised by seasonally waterlogged clay loam over clay, developed in mudstone;
- soils of the Hodnet association are mapped to the west of the Proposed Scheme across variable topography and are developed on a range of thin drifts over mudstone. They consist of reddish loams over slowly permeable clayey lower subsoils, with slight to moderate seasonal waterlogging;

- to the west of Madeley, the soils of the Clifton association are mapped, developed in reddish till. The soils are mostly of clay loam or sandy clay loam and are seasonally waterlogged; and
- across lower slopes and shallower gradients east and south of Madeley, and to the south of Wrinehill, are sandy loams and sands of the Wick 1 association. The soils, locally over gravel, are mostly well drained.

2.5.3 Soils of the Wick 1, Bridgnorth, Whimple 3, Goldstone and Clifton associations[9] are shown in a landscape context in Figure 1.

Figure 1: Wick 1, Bridgnorth, Whimple 3, Goldstone and Clifton soil associations in a landscape context[9]



2.5.4 Detailed descriptions are available for the predominant soil series of the Brockhurst and Clifton associations[1], and are given in Table 3.

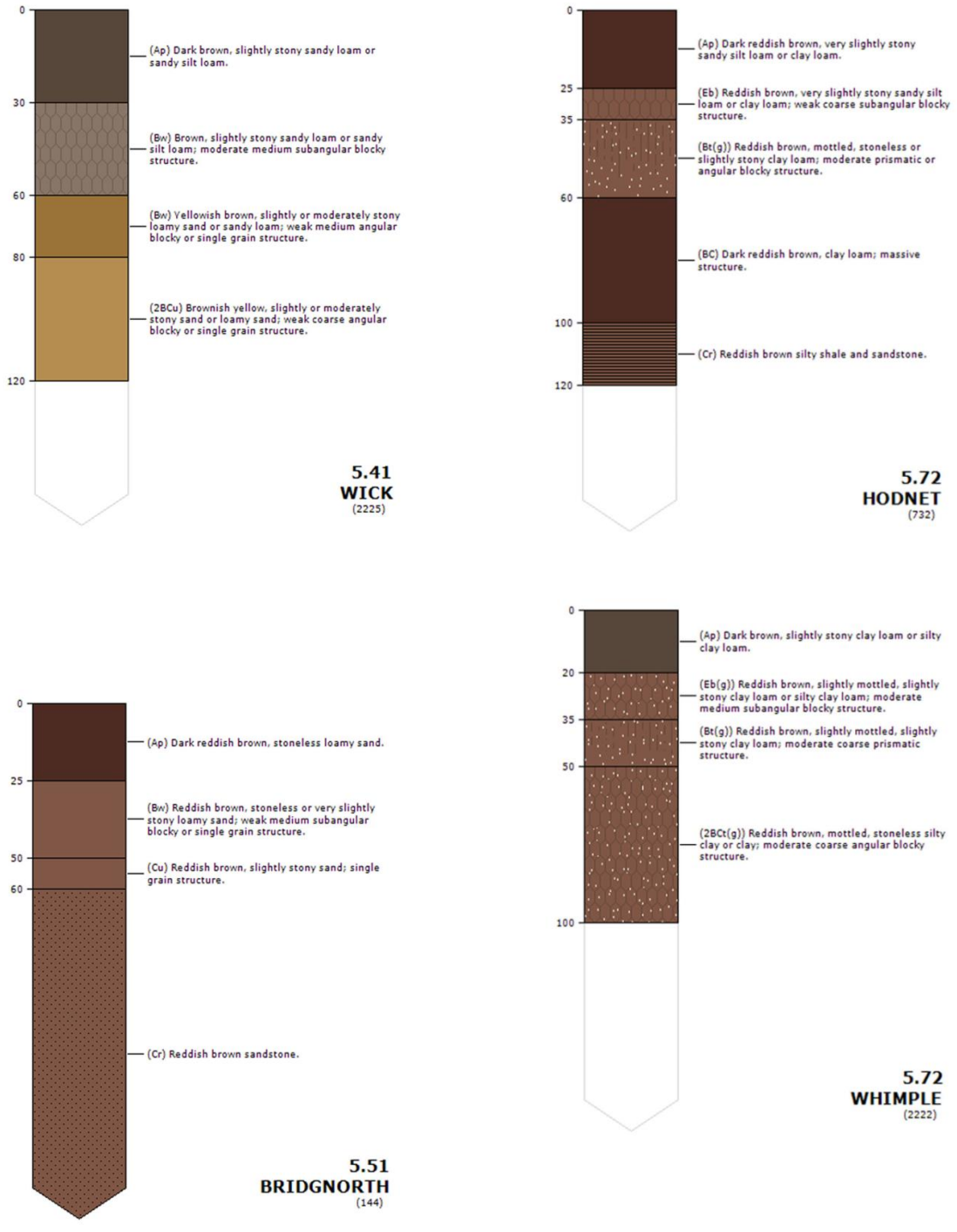
Table 3: Dominant soil series

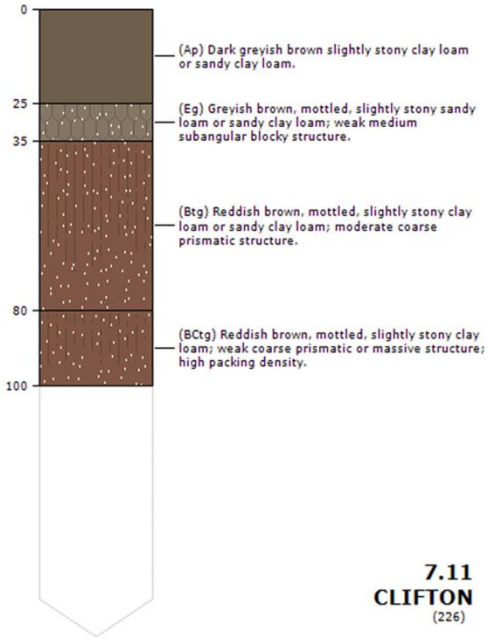
Brockhurst series
0 – 15cm, Very dark brown (7.5YR2/2[11]) very slightly stony clay loam; medium rounded, quartzite; moist; moderately developed fine subangular block; low packing density; moderately porous; moderately weak soil strength; moderately firm ped strength; abundant fine fibrous roots; slightly calcareous; abrupt smooth boundary.
15 – 28cm, Brown (7.5YR5/4) very slightly stony clay loam with common fine yellowish red (5YR5.8) mottles; medium rounded, quartzite; moist; moderately developed medium subangular blocky; medium packing density; moderately firm soil and ped strength; abundant fine fibrous roots; non-calcareous; few irregular soft ferri-manganiferous concentrations; abrupt smooth boundary.
28 - 47cm, Pale brown (10YR6/3) very slightly stony clay loam with many coarse yellowish brown (10YR5/6) mottles; medium rounded quartzite; moist; strongly developed medium prismatic; high packing density; very firm soil strength; abundant fine fibrous roots; non-calcareous; common irregular soft ferruginous concentrations; clear irregular boundary.
47 - 79cm, Reddish brown (5YR4/4) stoneless clay with many medium greenish grey (5GY6/1) mottles; moist; strongly developed coarse prismatic with reddish brown (5YR5/4) faces; high packing density; very firm soil strength; common very fine fibrous roots; non-calcareous; common irregular soft ferri-manganiferous concentrations; many stress oriented coats; clear irregular boundary.
79 - 104cm, Reddish brown (5YR4/4) very slightly stony clay with common very fine greenish grey (5GY6/1) mottles; small angular and platy, siltstone; moist; strongly developed fine angular blocky with reddish brown (5YR5/4) faces; high packing density; moderately weak soil strength; moderately firm ped strength; non-calcareous; common irregular ferri-manganiferous nodules; common clay coats.
Clifton series
0 – 23cm, Dark greyish brown (10YR4/2) slightly stony sandy clay loam; large rounded, quartzite; moist; strongly developed coarse subangular blocky; high packing density; moderately firm soil and ped strength; many fine fibrous roots; non-calcareous; sharp wavy boundary.
23 - 37cm, Light grey to grey (10YR6/1) slightly stony sandy loam with many fine yellowish brown (10YR5/6) mottles; large rounded, quartzite; moist; weakly developed, adherent medium subangular blocky; high packing density; moderately firm soil and ped strength; common very fine fibrous roots; non-calcareous; few irregular ferri-manganiferous nodules; abrupt way boundary.
37 - 86cm, Reddish brown (5YR4/4) slightly stony clay loam with common fine light grey to grey (10YR6/1) and strong brown (7.5YR5/6) mottles; large rounded quartzite; moist; strongly developed very coarse prismatic with greyish brown (10YR5/2) faces; high packing density; very firm soil strength; few very fine fibrous roots; non-calcareous; many clay coats; gradual smooth boundary.
86 - 107cm, Reddish brown (2.5YR4/4) slightly stony clay loam with common medium grey (N5/0) mottles; medium rounded, quartzite; moist; massive; high packing density; moderately strong ped strength; common clay coats

[11] Notations according to the Munsell Soil Color Book (2009). In this example, 7.5YR is the hue; 2/2 is the value/chroma

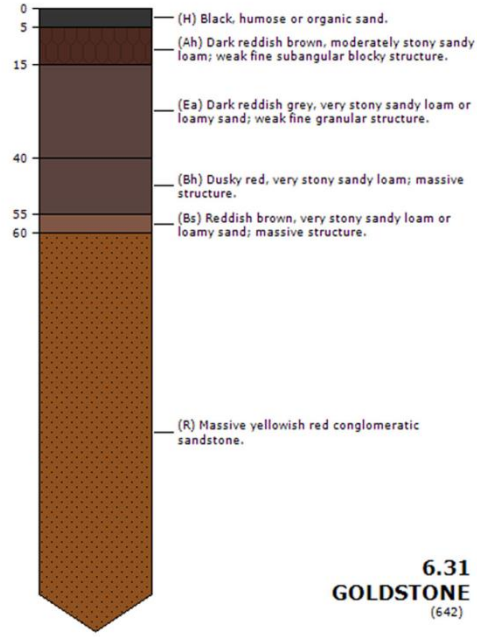
2.5.5 Typical soil profiles of the main series of each association[9] are depicted and described in Figure 2.

Figure 2: Predominant soil series profile descriptions

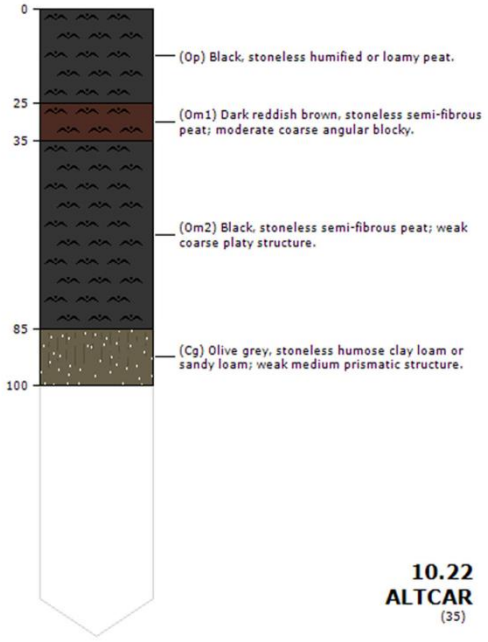




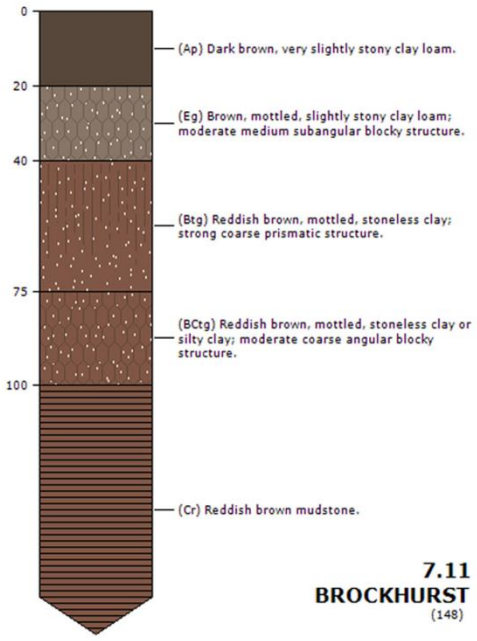
7.11
CLIFTON
(226)



6.31
GOLDSTONE
(642)



10.22
ALTCAR
(35)



7.11
BROCKHURST
(148)

2.6 Soil and land use interactions

Agricultural land quality

2.6.1 A review of available ALC information has been undertaken to ascertain the agricultural land quality within the study area. The review sought to identify the extent of any existing, detailed post-1988 ALC information to ensure that surveys are not repeated unnecessarily. Detailed ALC survey data is available for land to the south-east of Madeley[12].

2.6.2 The assessment has been supplemented using archived Soil Survey records obtained from the National Soil Resources Institute (NSRI) at Cranfield University and with detailed soil surveys undertaken in 2016 specifically for the purpose of this assessment.

Detailed agricultural land classification

2.6.3 Archived auger bores from the NSRI were obtained and used for reference in this ALC assessment. Additional field surveys were undertaken between Whitmore and Whitmore Heath.

2.6.4 The principal physical factors influencing agricultural production and land quality in this study area are climate, site and soil and the interactions between them. Soil wetness and workability and gradient of slope are particularly relevant limitations in this area.

2.6.5 During the detailed soil survey, soil profiles were examined using an Edelman (Dutch) auger and a spade. At each observation point the following characteristics were assessed for each soil horizon up to a maximum of 120cm where possible, or to any impenetrable layer:

- soil texture;
- significant stoniness;
- colour (including local gley and mottle colours);
- consistency;
- structural condition;
- free carbonate; and
- depth.

2.6.6 Soil Wetness Class (WC[10]) was inferred from the matrix colour, presence or absence of, and depth to, greyish and ochreous gley mottling and/or poorly permeable subsoil layers at least 15cm thick. Soil available water capacity, relevant to the assessment of drought risk, was estimated from texture, structure, organic matter content, stone content and profile depth.

[12] MAFF (1997), *Staffordshire and Stoke on Trent Minerals Local Plan, Netherset Hey Farm, Madeley*, Agricultural Land Classification

Agro-climatic limitations

2.6.7 The local agro-climatic factors have been interpolated from the Meteorological Office's standard 5km grid point dataset at three points within the study area, as set out in Table 4. There is very little variation across the study area. Average annual rainfall is from 791 to 797mm, increasing with altitude. Median Field Capacity Days (FCDs) are from 187 to 191 days. Moisture deficits are 78–82mm for wheat and 61-67mm for potatoes, with the lower values occurring on the highest ground.

Table 4: Interpolated agro-climatic data

Agro-climatic parameter	**SJ806404 Whitmore South**	**SJ790418 Whitmore Wood**	**SJ760448 Madeley West**
Altitude (AOD)	120m	145m	125m
Average annual rainfall	791mm	797mm	794mm
Accumulated temperature >0°C[13]	1334 day°	1305 day°	1327 day°
Field capacity days (FCD)	191 days	191 days	187 days
Average moisture deficit, wheat	80mm	78mm	82mm
Average moisture deficit, potatoes	65mm	61mm	67mm

2.6.8 Climate has an overriding limitation to Grade 2 at Whitmore Wood and west of Madeley, but is not limiting south of Whitmore. The interactions of climate with soil characteristics are important in determining further limitations to agricultural land quality through wetness and droughtiness.

2.6.9 The influence of climate on soil wetness is assessed by reference to median FCDs (when the soil moisture deficit is zero), soil WC and topsoil texture. The ALC grade according to soil wetness is then determined by following the methodology set out in the ALC Guidelines[8] and the information in Table 5.

[13] Accumulated temperature is the excess of daily air temperatures above a selected threshold temperature (0°C), summed over a specified period (January to June which is the critical growth period for most crops)

Table 5: ALC grade according to soil wetness – mineral soils

Wetness class	Texture of the top 25cm	Field Capacity Days				
		<126	126-150	151-175	176-225	>225
I	Sand (S) Loamy Sand (LS) Sandy Loam (SL) Sandy Silt Loam (SZL)	1	1	1	1	2
	Silty Loam (ZL) Medium Silty Clay Loam (MZCL) Medium Clay Loam (MCL) Sandy Clay Loam (SCL)	1	1	1	2	3a
	Heavy Silty Clay Loam (HZCL) Heavy Clay Loam (HCL)	2	2	2	3a	3b
	Sandy Clay (SC) Silty Clay (ZC) Clay (C)	3a (2)	3a (2)	3a	3b	3b
II	S LS SL SZL	1	1	1	2	3a
	ZL MZCL MCL SCL	2	2	2	3a	3b
	HZCL HCL	3a (2)	3a (2)	3a	3a	3b
	SC ZC C	3a (2)	3b (3a)	3b	3b	3b
III	S LS SL SZL	2	2	2	3a	3b
	ZL MZCL MCL SCL	3a (2)	3a (2)	3a	3a	3b
	HZCL HCL	3b (3a)	3b (3a)	3b	3b	4
	SC ZC C	3b (3a)	3b (3a)	3b	4	4
IV	S LS SL SZL	3a	3a	3a	3b	3b
	ZL MZCL MCL SCL	3b	3b	3b	3b	3b
	HZCL HCL	3b	3b	3b	4	4
	SC ZC C	3b	3b	3b	4	5
V	S LS SL SZL	4	4	4	4	4
	ZL MZCL MCL SCL	4	4	4	4	4
	HZCL HCL	4	4	4	4	4
	SC ZC C	4	4	4	5	5

Notes. From Table 6 of ALC Guidelines[8]
For naturally calcareous soils with more than 1% calcium carbonate ($CaCO_3$) and between 18% and 50% clay in the top 25cm, the grade, where different from that of other soils, is shown in brackets.
Sand (S) topsoil is not eligible for Grades 1,2 or 3a.
Loamy sand (LS) topsoil is not eligible for Grade 1.

2.6.10 Soil droughtiness is determined by comparing crop-adjusted available water (AP), with the moisture deficit (MD) for the locality for wheat and potatoes (MAFF ALC Guidelines, Appendix 4)[8]. Grading of the land can be affected if the AP is insufficient to balance the MD and droughtiness occurs. The calculation used in the ALC Guidelines to determine the severity of this limitation is given below in Figure 3.

Figure 3: Methodology for calculating the severity of a droughtiness limitation to ALC grading

$$\text{AP wheat (mm)} = \frac{TA_{vt} \times LT_t + \Sigma (TA_{vs} \times LT_{50}) + \Sigma (EA_{vs} \times LT_{50\text{-}120})}{10}$$

where

TA_{vt} is Total available water (TA_v) for the topsoil texture

TA_{vs} is Total available water (TA_v) for each subsoil layer

EA_{vs} is Easily available water (EA_v) for each subsoil layer

LT_t is thickness (cm) of topsoil layer

LT_{50} is thickness (cm) of each subsoil layer to 50 cm depth

$LT_{50\text{-}120}$ is thickness (cm) of each subsoil layer between 50 and 120 cm depth

Σ means 'sum of'.

$$\text{AP potatoes (mm)} = \frac{TA_{vt} \times LT_t + \Sigma (TA_{vs} \times LT_{70})}{10}$$

where

LT_{70} is thickness (cm) of each subsoil layer to 70 cm depth

MB (Wheat) = **AP** (Wheat) **- MD** (Wheat)
MB (Potatoes) = **AP** (Potatoes) **- MD** (Potatoes)

Where
MB is the Moisture Balance
AP is the Crop-adjusted available water capacity
MD is the moisture deficit, as determined by the agro-climatic assessment.

Grade according to droughtiness

Grade/ Subgrade	Moisture Balance limits (mm) *wheat*		*potatoes*
1	+30	*and*	+10
2	+5	*and*	-10
3a	-20	*and*	-30
3b	-50	*and*	-55
4	<-50	*or*	<-55

Derived from MAFF[8]

Site limitations

2.6.11 The assessment of site limitations is primarily concerned with the way in which topography influences the use of agricultural machinery and hence the cropping potential of land. In addition, gradient influences the risk of soil erosion on cultivated land, particularly where the soil is weakly structured. Gradient and microrelief are limiting to agricultural land quality throughout this study area. The valley slopes to the River Lea are steep throughout and limit land quality variably to Subgrade 3b and Grade 4, where slopes measure 7-11 degrees and 11-18 degrees respectively. Gradients with a Subgrade 3b limitation were also measured south of Whitmore on the slopes to the Meece Brook.

2.6.12 Flood risk is also limiting to agricultural land quality within the Lea Valley and potentially south-east of Checkley. This is a potential limitation but its incidence and severity is difficult to ascertain. Flood risk is determined by the extent, duration, frequency and timing of flooding events which may not have been recorded.

Soil limitations

2.6.13 The main soil properties which affect the cropping potential and management requirements of land are texture, structure, depth, stoniness and chemical fertility. Together they influence the functions of soil and affect the water availability for crops, drainage, workability and trafficability. The main soil characteristics within the study area are:

- light loamy and sandy textures which are well drained;
- loamy over clayey textures, commonly with poor subsoil structure and slow permeability; and
- organic, peat soils associated with water courses.

2.6.14 Soil depth and chemical limitations are not encountered in this study area.

Interactive limitations

2.6.15 The physical limitations which result from interactions between climate, the site and soil are soil wetness, droughtiness and erosion. Each soil can be allocated a WC based on soil structure, evidence of waterlogging and the number of FCDs; the topsoil texture then determines its ALC Grade in accordance with Table 6 of the MAFF ALC guidelines (as detailed in Table 5).

2.6.16 Light loamy and sandy soils of the Bridgnorth, Goldstone and Wick associations are most affected by soil droughtiness. The severity of limitation is determined by factors such as topsoil texture, stone content and depth to the sandstone bedrock. As crop moisture deficits are moderate to moderately small, droughtiness limitations are mostly slight to Grade 2.

2.6.17 The presence of this soil type has been confirmed throughout the study area in detailed surveys undertaken for the purpose of this assessment to the east of Whitmore Heath and south of Whitmore, and in the NSRI data. The collective data has identified thick sandy loam and loamy sand topsoils of 38cm average depth, overlying

loamy sand and sand subsoils. The profiles are classified as Grade 2, limited by soil droughtiness.

2.6.18 The Goldstone association is likely to have a more severe droughtiness limitation to Grade 4 or 5, as reflected in the typical land use of heath and woodland, which may also be a direct result of its inherent acidity.

2.6.19 The medium loamy over clayey soils of the Brockhurst 1, Whimple 3, Hodnet and Clifton associations have also been identified at Whitmore, as well as in surveys undertaken by MAFF to the south of Madeley, in additional surveys at Wrinehill and in the NSRI profile data.

2.6.20 The topsoil is most commonly of medium clay loam and occasionally heavy clay loam or sandy clay loam, of 23cm average depth. Subsoil is of similar texture but also includes clay, and is typically gleyed and slowly permeable. The profiles are of WC III or IV. Soils of WC III are limited by wetness and workability to Subgrade 3a where the topsoil texture is medium or sandy clay loam, or more severely to Subgrade 3b where the topsoil texture is of heavy clay loam.

2.6.21 Soil profiles of WC IV with medium or sandy clay loam topsoil are of Subgrade 3b, whilst those with heavier topsoils are of Grade 4.

2.6.22 The peat soils of the Altcar 1 association are mapped in conjunction with the Meece Brook and the River Lea. Though not a complete profile, a detailed soil survey at Whitmore identified a subsoil horizon of black humified peat in very close proximity to the Meece Brook. The topsoil comprises slightly organic sandy clay loam and the lower subsoil is of sand which, though not gleyed was inundated with water.

2.6.23 Where drainage measures are not installed, as assumed at Meece Brook, peaty profiles of WC IV would be limited to Subgrade 3a by wetness and workability. If more severely or even permanently waterlogged, of WC V or VI, as is likely to be the case in the Lea Valley where the area is classified as Flood Zone 3, the profiles would be classified as Grade 4 or 5.

2.6.24 Where drainage has been installed, peaty profiles will have sufficient water holding capacity to prevent any drought stress to crops and, if well drained, may have only slight or no physical limitation to agricultural land quality. However, these soils are susceptible to compaction when wet and wind erosion when dry.

3 Forestry

3.1.1 Assessment of forestry resources has primarily had regard to the National Forestry Inventory[14] and its predecessor, the National Inventory of Woodland and Trees[15], and to data collected from landowners and tenants in the farm impact assessments.

3.1.2 The area of woodland within a 4km wide corridor (2km either side of the route centre line of the Proposed Scheme) has been determined using GIS, and is shown in Table 6.

3.1.3 Woodland is found predominantly around Whitmore Heath, although there are some smaller blocks near Madeley.

3.1.4 The larger blocks of woodland in the area include Whitmore Wood, Hey Sprink, Barhill Wood and Wrinehill Wood.

3.1.5 Most of Whitmore Wood Ancient Woodland is managed as commercial forestry. It was replanted with mostly larch for commercial extraction approximately 40 years ago, has been thinned and will be extracted once mature.

Table 6: Area of woodland within the study area and construction boundary

	Area of woodland within 2km either side of centreline		**Woodland permanently required**	
	ha	**%**	**ha**	**%**
Ancient woodland	134.2	37	7.0	30
Broadleaved	180.2	50	3.2	13
Coniferous	32.2	9	0.0	0
Other	14.0	4	13.5	57
Total woodland	360.6	100	23.7	100
Woodland as % of total land within 2km either side of centreline		9.9		

[14] Forestry Commission, National Forest Inventory. https://www.forestry.gov.uk/inventory
[15] Forestry Commission, National Inventory of Woodland and Trees. https://www.forestry.gov.uk/fr/infd-86xc6c

4 Assessment of effects on holdings

4.1.1 The effects on holdings have been assessed according to the methodology set out in the Phase 2a Scope and Methodology Report (SMR) and the SMR Addendum which are set out in Volume 5: Appendix CT-001-001 and Appendix CT-001-002. A summary of the assessment is provided in Table 7. The nature of impacts considered comprises the temporary and permanent land required from the holding, the temporary and permanent severance of land, the permanent loss of key farm infrastructure and the imposition of disruptive effects (particularly noise and dust) on land uses and the holding's operations. These impacts occur primarily during the construction phase of the Proposed Scheme.

Table 7: Summary of assessment of effect on holdings

Holding reference, name and description	Temporary effects	Permanent effects
CA4/1 Whitmore Hall Farm Part of the Whitmore Hall Estate, with the farmland tenanted by the family. 365ha dairy unit with substantial diversification including fishery in 12 pools, commercial shoot in Whitmore Wood, Veolia composting site, 50-horse livery, telecommunications tower in woodland. Main operational dairy unit at Hillside Farm. Entry Level Stewardship (ELS) and Higher Level Stewardship (HLS) schemes, including wetland for wintering waders near West Coast Main Line (WCML).	Land required: High. 85.3ha; 23% of holding required for construction. Agricultural land required from two blocks in the west of the farm between Bent Lane and A53 Newcastle Road; and between A53 Newcastle Road and Whitmore Heath (for cut and cover tunnel). Includes A53 Newcastle Road transfer node, Stableford North embankment satellite compound, Whitmore Heath (south) tunnelling facility and logistics area, A53 Newcastle Road temporary diversion and temporary material stockpile. Forestry land required from Whitmore Wood. Severance: Low. Land between Bent Lane and A53 Newcastle Road severed with access available beneath the Meece Brook viaduct. Access available on land north of A53 Newcastle Road to north of the cut and cover section of Whitmore Heath tunnel. Disruptive effects: Low. Potential effects on amenity of shoot and deer stalking associated with woodland.	Land required: Medium 66.6ha; 18% of holding required. Agricultural land required from one block between Bent Lane and A53 Newcastle Road for Whitmore south cutting, tunnel portal building and rescue area, balancing pond, ecological and landscape mitigation planting. Forestry land required (1.6ha of semi-natural broad-leaved and 4.5ha of larch plantation) reduced by Whitmore Wood retaining wall. Severance: Low. Land between Bent Lane and A53 Newcastle Road severed with access available beneath the Meece Brook viaduct. Severance in Whitmore Wood mitigated by Whitmore Wood overbridge. Infrastructure: Negligible
ESCA4/2* Baldwin's Gate Farm 254ha dairy unit	Land required: Negligible 7.0ha; 3% of holding required for construction. Agricultural land required from one block north of A53 Newcastle Road for Whitmore Heath tunnel satellite compound and construction works. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 3.6ha; 1% of holding required from land north of A53 Newcastle Road for southern porous portal of Whitmore Heath tunnel and landscape mitigation planting. Severance: Negligible Infrastructure: Negligible

Holding reference, name and description	Temporary effects	Permanent effects
CA4/3* Rose Cottage 1ha rough pasture	Land required: High 1.0ha; 100% of holding required for construction. Agricultural land required from one block north of A53 Newcastle Road for construction works. Severance: Negligible Disruptive effects: Negligible	Land required: High 1.0ha; 100% of holding required. Agricultural land required from one block north of A53 Newcastle Road for balancing pond, ecological mitigation pond and planting. Severance: Negligible Infrastructure: Negligible
CA4/4* New House Farm 20ha grassland farm, grazed by beef herd.	Land required: Negligible 0.2ha; 1% of holding required for construction. Land required from strip west of Snape Hall Road to allow for construction works for highway improvements. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 0.0ha (0%) of holding required. Land required from strip west of Snape Hall Road for highway improvements. Severance: Negligible Infrastructure: Negligible
CA4/5 Moat Farm Tenanted 89ha grassland farm, grazed by suckler beef herd.	Land required: Low 6.8ha; 8% of holding required for construction. Agricultural land required from one block either side of Snape Hall Road for Whitmore Heath (north) tunnelling facility and logistics area. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 4.5ha; 5% of holding required. Agricultural land required from one block either side of Snape Hall Road for the northern porous portal of Whitmore Heath tunnel and landscape/habitat creation. Severance: Negligible Infrastructure: Negligible
CA4/6 Snape Hall Farm Owner-occupied 108ha dairy unit with 2.8ha commercial forestry to north-east of holding.	Land required: High 44.0ha; 41% of holding required for construction. Agricultural land required from one block extending north and south of Whitmore Wood for Whitmore North cutting satellite compound, River Lea viaduct launching yard and stockpiles. Severance: Medium Farm severed in two along its length and Snape Hall Road closed. Access from farm buildings and land to the west of the Proposed Scheme to severed land to the east provided by Whitmore Wood overbridge. Disruptive effects: Medium Disruption around farm buildings	Land required: High 32.4ha; 30% of holding required. Agricultural land required from one block extending north and south of Whitmore Wood for Whitmore North cutting, tunnel portal building and rescue area, Whitmore north auto-transformer station, balancing pond, access road, Lea South embankment and landscape and habitat creation. Severance: Medium Farm severed in two along its length and Snape Hall Road closed. Access from farm buildings and land to the west of the Proposed Scheme to severed land to the east provided by Whitmore Wood overbridge. Infrastructure: High Demolition of 465m^2 livestock building to north-east of farmstead.

Holding reference, name and description	Temporary effects	Permanent effects
CA4/7* Woodhouse Farm 46ha grassland farm grazed by beef cattle and sheep.	Land required: Negligible 1.6ha; 4% of holding required for construction. Agricultural land required from one block north of Whitmore Wood for construction works. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 1.6ha; 4% of holding required. Agricultural land required from one block north of Whitmore Wood for habitat creation. Severance: Negligible Infrastructure: Negligible
CA4/8 Netherset Hey Farm Owner-occupied 324ha dairy and free-range poultry. Shoot in woodland.	Land required: High 74.1ha; 23% of holding required for construction. Agricultural land required from two blocks: an area east of the West Coast Mainline (WCML) required for borrow pit; and an area west of Madeley for Madeley tunnel (south) satellite compound and stockpile. Severance: Low Small area of land severed west of Madeley, during construction, although access expected to be allowed over Madeley tunnel. Disruptive effects: Low	Land required: Low 24.6ha; 8% of holding required. Agricultural land required from one block west of Madeley for the southern porous portal of Madeley tunnel and landscape mitigation planting. Severance: Low Access to severed land to west of Madeley maintained via private way and over Madeley tunnel. Infrastructure: Negligible
CA4/9 Madeley Park Farm Owner-occupied 91ha beef cattle, sheep and pigs with on-site abattoir and farm shop (Mitchells Wood Farm Shop) selling farm-produced meat and eggs.	Land required: Low 6.9ha; 8% of holding required for construction. Agricultural land required from one block west of WCML for construction works to River Lea viaduct. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 3.1ha; 3% of holding required. Agricultural land required from one block west of WCML for footings of River Lea viaduct and watercourse diversion. Severance: Negligible Infrastructure: Negligible
CA4/10 Manor Farm Owner-occupied 152ha self-contained dairy unit within overall holding of 660ha. Dairy unit managed on an extensively grazed New Zealand system, with farm split into 50 paddocks. Woodland managed for amenity (paintballing), shoot and ponds let for fishing; four barn conversions let out.	Land required: High 49.1ha; 32% of holding required for construction. Agricultural land required from one block either side of Manor Road for River Lea viaduct satellite compound and soils and material storage. Severance: Medium Access available to severed land to the east of Manor Road using public highway. Disruptive effects: Medium Disruption to grazing paddock organisation.	Land required: Medium 21.1ha; 14% of holding required. Agricultural land required from one block either side of Manor Road, for realigned Manor Road, balancing ponds and habitat creation. Severance: Low Post construction, access available to severed land via private rights of way (under the River Lea viaduct, via the split use of Manor Road overbridge and across realigned Manor Road). Infrastructure: Medium Continued effective drainage is critical for the dairy system operated at the farm, which relies on extended grazing.

Holding reference, name and description	Temporary effects	Permanent effects
CA4/11 Land at Wood Croft Owner-occupied and grazing licence 6ha semi-commercial equestrian unit	Land required: High 5.2ha; 86% of holding required for construction. Land required from one block south of Red Lane for construction works. Severance: Low Small severed area to west with access available via Red Lane. Disruptive effects: Low	Land required: High 5.0ha; 83% of holding required. Land required from one block south of Red Lane for Madeley cutting, habitat creation and ponds. Severance: Negligible Infrastructure: Negligible
CA4/12 Baa Hill Farm Full agricultural tenancy 36ha sheep, pigs and beef cattle, with a farm butchery and shop (Baa Hill Farm Shop) selling farm-produced meat and other local produce; ponds rented to angling club.	Land required: High 12.6ha; 35% of holding required for construction. Agricultural land required from one block south of A525 Bar Hill Road for Madeley cutting satellite compound, Madeley cutting transfer node, and stockpile. Fishing ponds removed. Severance: Medium Severed parcel of land to the east of holding accessible from A525 Bar Hill Road during construction. Disruptive effects: High Extent and proximity of construction activity likely to have a substantial impact on scale of farmed livestock, and on customer perceptions of the farm and farm shop.	Land required: Medium 7.1ha; 20% of holding required. Agricultural land required from one block south of A525 Bar Hill Road for Madeley cutting, Drummer Stile inverted siphon access tracks, landscape and habitat creation. Severance: Low Severed land to the east accessed via the Madeley Bridleway 1 accommodation green overbridge. Infrastructure: Low
CA4/13* Peak's Farm 44ha dairy farm	Land required: Negligible 1.0ha; 2% of holding required for construction. Agricultural land required from one block south of A525 Bar Hill Road for construction works. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 1.0ha; 2% of holding required. Agricultural land required from one block south of A525 Bar Hill Road for habitat creation. Severance: Negligible Infrastructure: Negligible
CA4/14* Land at Bar Hill 2ha grassland	Land required: Low 0.2ha; 10% of holding required for construction. Agricultural land required from one block south of A525 Bar Hill Road for construction works. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 0.0ha; 0% of holding required. Severance: Negligible Infrastructure: Negligible
CA4/15* Chells Hill Farm 1ha grassland; off-lying parcel of land from c25ha at Chells Hill Farm, including recent inland waterways marina; remainder is grazing for beef cattle.	Land required: Negligible 0.7ha; 3% of holding required for construction. Agricultural land required from one block north of A525 Bar Hill Road for Madeley tunnel (south) transfer node. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 0.7ha; 3% of holding required. Agricultural land required from one block north of A525 Bar Hill Road for landscape mitigation planting. Severance: Negligible Infrastructure: Negligible

Holding reference, name and description	Temporary effects	Permanent effects
CA4/16 Bar Hill Farm Owner-occupied 233ha beef cattle and arable unit, with a shoot and agricultural contracting business.	Land required: Negligible 11.2ha; 5% of holding required for construction. Agricultural land required from two blocks; an area east of Bar Hill Wood for Madeley tunnel (south) satellite compound, Madeley Tunnel (south) tunnelling facility and logistics area, and an area south of Bower End Lane for construction works. Severance: Negligible Disruptive effects: Medium Construction impacts on shoot.	Land required: Negligible 9.4ha; 4% of holding required. Agricultural land required from two blocks; an area east of Bar Hill Wood for Madeley cutting, tunnel portal building and rescue area to the south of Madeley tunnel, habitat creation and landscape mitigation planting; and an area south of Bower End Lane for balancing pond and habitat creation. Severance: Negligible Infrastructure: Negligible
CA4/17* Land at Moor Hall 1ha grassland used to graze horses (non-commercial)	Land required: High 0.2ha; 24% of holding required for construction. Agricultural land required from one strip south of Bower End Lane allow for construction works for highway improvements. Severance: Negligible Disruptive effects: Negligible	Land required: Low 0.1ha; 10% of holding required. Agricultural land required from one strip south of Bower End Lane for highway widening. Severance: Negligible Infrastructure: Negligible
CA4/18 Bower End Farm Owner-occupied 25ha beef cattle and sheep unit	Land required: High 8.8ha; 35% of holding required for construction. Agricultural land required from one block north of Bower End Lane for Madeley tunnel (north) satellite compound, Madeley Tunnel (north) tunnelling facility and logistics area. Severance: Negligible Disruptive effects: Low Proximity of construction works to farm unit has potential to affect daily operation.	Land required: High 6.4ha; 26% of holding required. Agricultural land required from one block north of Bower End Lane for the northern porous portal of Madeley tunnel, tunnel portal building and rescue area, associated access road, landscape mitigation planting and habitat creation. Severance: Negligible No severance; access available over the Madeley tunnel. Infrastructure: Medium Borehole feeding house, farm and neighbouring property over Madeley tunnel.
CA4/19 Beechwood Farm Owner-occupied 105ha beef cattle and sheep unit Countryside Stewardship	Land required: Negligible 5.3ha; 5% of holding required for construction. Agricultural land required from one block west of WCML for construction works and stockpile. Severance: Negligible Disruptive effects: Negligible	Land required: Negligible 5.3ha; 5% of holding required. Agricultural land required from one block west of WCML for main alignment, landscape and habitat creation. Severance: Negligible Infrastructure: Negligible

Holding reference, name and description	Temporary effects	Permanent effects
CA4/20 Wrinehill Hall Farm 230ha dairy unit	Land required: Medium 33.4ha; 15% of holding required for construction. Agricultural land required from one block west of WCML for Checkley South embankment satellite compound, stockpile and construction works. Severance: Low Access to severed land provided via private way during construction works. Disruptive effects: Medium Location of construction area close to farm buildings, and the position of the works through the middle of the holding would be likely to require substantial changes to the operation of the farm.	Land required: Low 16.3ha; 7% of holding required. Agricultural land required from one block west of WCML for Checkley South embankment, balancing pond, landscape and habitat creation. Severance: Low Use of the Madeley Bridleway 2 accommodation underbridge and Checkley Brook viaduct to access severed land. Infrastructure: Low Impacts on layout of farm access tracks.
CA4/21 Wrinehill Mill Farm 22ha equestrian unit with buildings also let out (children's swimming lessons).	Land required: Negligible 0.3ha; 2% of holding required for construction. Agricultural land required from one block between Checkley Brook and River Lea for construction works to Checkley Brook viaduct. Severance: High. Parcel of land severed by scheme with no access available whilst viaduct is under construction. Disruptive effects: Negligible	Land required: Negligible 0.1ha; <1% of holding required. Agricultural land required from one block between Checkley Brook and River Lea for footings of Checkley Brook viaduct. Severance: Negligible Infrastructure: Negligible

* No Farm Impact Assessment interview conducted; data estimated.

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