

High Speed Rail (West Midlands - Crewe)

Environmental Statement

Volume 5: Technical appendices

CA1: Fradley to Colton

Water resources assessment (WR-002-001)

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Department
for Transport

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1 Introduction

1.1 Structure of the water resources and flood risk appendices

1.1.1 The water resources and flood risk assessment appendices comprise both route-wide and community area specific documents. The route-wide appendices comprise:

- a Water Framework Directive (WFD) compliance assessment (Volume 5, Appendix WR-001-000); and
- a water resources operation and maintenance plan (Volume 5, Appendix WR-005-000).

1.1.2 For the Fradley to Colton area (CA1), the area specific appendices comprise:

- a water resources assessment (this appendix); and
- a flood risk assessment (Volume 5, Appendix WR-003-001).

1.1.3 Hydraulic modelling reports, which describe the approach to assessing key flood risk issues identified within the community area, are included in Background Information and Data (BID)¹.

1.1.4 Maps (WR-01, WR-02) referred to throughout this assessment are contained in the Volume 5, Water resources and flood risk Map Book. The route will be constructed on a series of cuttings and embankment and four viaducts: Pyford Brook viaduct, Kings Bromley viaduct, River Trent viaduct and Moreton Brook viaduct.

1.2 Scope, assumptions and limitations

1.2.1 The scope, assumptions and limitations for the water resources assessment are set out in Volume 1 (Section 8), the Scope and Methodology Report (SMR)² and the SMR addendum³.

1.2.2 The Fradley to Colton area covers a 13.5km long section of the Proposed Scheme. The spatial scope of the assessment is based upon the identification of surface water and groundwater features within 1km of the centre line of the route of the Proposed Scheme. However, the spatial scope has been extended to include the interfaces with Phase One, utility works along the B5103 Uttoxeter Road, works to Gorse Lane and diversion of the National Grid 400kV overhead power line and the 132kV power line from the substation at the former Rugeley Power Station to the Newland's Lane auto-transformer feeder station. For the purposes of this assessment this spatial scope is defined as the study area.

1.2.3 The assessment considers the construction and operational features of the Proposed Scheme within this study area. These are shown on Volume 2: Map Series CT-05 and Map Series CT-06. The route will be constructed on a series of cuttings and embankments and four viaducts: Pyford Brook viaduct, Kings Bromley viaduct, River Trent viaduct and Moreton Brook viaduct.

¹ HS2 Ltd (2017), *High Speed 2 (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data, Hydraulic Modelling Reports. BID-WR-004, www.gov.uk/hs2*

² Volume 5: Appendix CT-001-001, Scope and Methodology Report

³ Volume 5: appendix CT-001-002, Scope and Methodology Report Addendum

- 1.2.4 This assessment covers the potential impacts of the Proposed Scheme on existing surface water and groundwater resources, including consideration of:
- surface waters⁴;
 - aquifers;
 - abstractions (licensed and unlicensed) and consented discharges; and
 - springs and other groundwater-surface water interactions with implications for water resources and/or groundwater dependent terrestrial ecosystems.
- 1.2.5 The route-wide WFD compliance assessment (Volume 5: Appendix WR-001-000) provides a comprehensive review of the potential impacts of the Proposed Scheme on designated WFD surface water and groundwater bodies. The WFD compliance assessment, which involved extensive walkover surveys, informed both the value attributed to relevant receptors, such as watercourses, and the assessment of impacts and effects used in this assessment.
- 1.2.6 The water resources assessment considers the pollution risks associated with routine discharges of runoff from new sections of highway proposed within the study area, during the operational phase of the Proposed Scheme. This assessment uses the Highways Agency Water Risk Assessment Tool (HAWRAT) as presented in Design Manual for Roads and Bridges⁵.
- 1.2.7 Pollution risks associated with trains using the Proposed Scheme during its operational phase are considered on a route-wide basis within Volume 3, Route-wide effects, Section 16, Water resources and flood risk.

1.3 Study area description and key features

- 1.3.1 The study area is predominantly rural, although there are a number of villages, hamlets and farmsteads located within close proximity to the Proposed Scheme including Blithbury, Stockwell Heath and Colton. The small urban area of Kings Bromley is located to the east of the southern extent of the route.
- 1.3.2 Within the Fradley to Colton area the Proposed Scheme will be constructed on a series of cuttings and embankments. The only exceptions to this are the crossings of Pyford Brook, the River Trent floodplain at Kings Bromley and Moreton Brook, where the Proposed Scheme will be constructed on viaduct. There are no tunnelled or at grade sections.
- 1.3.3 The main environmental features of relevance to water resources include:
- the River Trent, Pyford Brook, Ashby Sitch, Bourne Brook, Crawley Brook, Moreton Brook, Luth Burn and their associated tributaries;
 - nine licensed surface water abstractions;
 - three potential spring features within the area required for construction of the Proposed Scheme;

⁴ Ponds are not included in the water resources assessment, these are assessed as ecological receptors in Volume 2, Colwich to Yarlet area report, Section 8, Ecology and biodiversity

⁵ Design Manual for Roads and Bridges, *Road Drainage and the Water Environment*, Volume 11 Environmental Assessment, Section 3, Environmental Assessment Techniques, Part 10, HD45/09

- the Sherwood Sandstone Group Principal aquifer;
- the Mercia Mudstone Group Secondary B aquifer;
- the permeable superficial deposits Secondary A aquifers;
- one groundwater abstractions licensed for public water supply;
- eight licensed private groundwater abstractions; and
- one unlicensed groundwater abstraction.

2 Stakeholder engagement

2.1.1.1 Discussions have been held with the following stakeholders to inform the water resources assessment:

- the Environment Agency;
- Stafford Borough Council (SBC) and Lichfield District Council (LDC), with regard to private unlicensed water abstractions;
- water companies to confirm details of public water abstractions (if and where present in the study area) and associated water resource management plans; and
- the owners of private licensed and unlicensed abstractions (where access has been available).

3 Baseline data

3.1 Surface water

- 3.1.1 The surface water features crossed by the Proposed Scheme within this study area, including their location, current overall WFD status and future overall status objectives, are tabulated in the Volume 2, Fradley to Colton area report, Section 15. The receptor values attributed to each individual watercourse, based on the methodologies set out in the SMR², as applied in the WFD compliance assessment (Volume 5, Appendix WR001-000) are also provided.
- 3.1.2 Table 1 summarises the surface water abstractions within the study area. Their locations are shown on Map WR-01-101 and Map WR-01-102a. There are nine licensed surface water abstractions, which have all been assessed to be high value receptors. None of these abstractions are for public water supply (PWS). One of these is located within the land required for the construction of the Proposed Scheme. Records of private unlicensed water abstractions for quantities less than 20m³ per day have been obtained from the local authorities Lichfield District Council and Stafford Borough Council. This data indicates that there are no registered private unlicensed surface water abstractions registered within the study area. As there is no obligation to register private water supplies, unregistered supplies may also be present. Private water supplies are assessed as high value receptors unless details obtained from the owner indicate otherwise.

Table 1: Surface water abstractions

Name, licence number (and map grid square)	Distance and direction from route	Abstraction source	Maximum annual abstraction quantity (m ³)	Maximum daily abstraction quantity (m ³)	Purpose
Private licensed supplies					
Wood End Farm, Curborough 03/28/07/0089 (H7) ⁶	0.72km south-west of the route (0.31km from the land required for construction of the Proposed Scheme)	Pyford Brook	9,000	500	Agriculture
Curborough Hall Farm 03/28/07/0068 (H6) ⁶	0.54km south-west of the route (0.27km from the land required for construction of the Proposed Scheme)	Pyford Brook	17,500	540	Agriculture
Kings Bromley – Ashby Sitch 03/28/07/0040 (F4) ⁶	0.75km north-east of the route (0.15km from the land required for construction of the Proposed Scheme)	Ashby Sitch	15,911	982	Agriculture

⁶ As shown on Map WR-01-101

Name, licence number (and map grid square)	Distance and direction from route	Abstraction source	Maximum annual abstraction quantity (m ³)	Maximum daily abstraction quantity (m ³)	Purpose
Kings Bromley – Bourne Brook Point 103/28/07/0040 (F4) ⁶	0.8km north-east of the route (adjacent to the land required for construction of the Proposed Scheme)	Bourne Brook	15,911	982	Agriculture
Kings Bromley – Bourne Brook Point 303/28/07/0040 (F3) ⁶	0.92km north-east of the route (0.3km from the land required for construction of the Proposed Scheme)	Bourne Brook	15,911	982	Agriculture
Kings Bromley – New River Trent lagoon 03/28/05/0039 (E5) ⁶	0.25km north-east of the route (within the land required for construction of the Proposed Scheme)	River Trent	1,059,000	4,546	Industrial, commercial and public services
The Echills, Kings Bromley 03/28/07/0096 (D4) ⁶	0.53km north-east of the route (0.5km from the land required for construction of the Proposed Scheme)	River Trent	4,546	545	Agriculture
Rugeley Power Station – River Trent 03/28/05/0057 (H8) ⁷	2.6km south-west of the route (adjacent to the land required for construction of the Proposed Scheme)	River Trent	36,004,320	141,290	Production of energy
Moreton Brook - Rugeley MD/028/0005/003 (E5) ⁷	0.71km south-west of the route (0.41km from the land required for construction of the Proposed Scheme)	Moreton Brook	75,000	1,200	Agriculture

3.1.3 There are 20 consented discharges to surface water within the study area, as shown in Table 2, none of which are within the land required for the construction of the Proposed Scheme. These have been assessed as low value receptors.

⁷ As shown on Map WR-01-102a

Table 2: Consented discharges to surface water

Permit identifier (and map grid square)	Distance and direction from route	Discharge type	Receiving water body
T/07/36033/R (H7) ⁸	0.98km south-west of the route (0.6km from the land required for construction of the Proposed Scheme)	Wastewater treatment works (WwTW) (Sewage - water company)	Full Brook
T/07/36033/R (H7) ⁸	1km south-west of the route (0.6km from the land required for construction of the Proposed Scheme)	WwTW (Sewage - water company)	Full Brook
T/22/35783/S (H4) ⁸	0.78km north-east of the route (0.3km from the land required for construction of the Proposed Scheme)	Holiday accommodation/ camp site/hotel/hostel (Sewage)	Trent and Mersey Canal
T/22/00171/S (H4) ⁸	0.78km north-east of the route (0.3km from the land required for construction of the Proposed Scheme)	Food and beverage services/café/restaurant/pub (Sewage)	Trent and Mersey Canal
T/07/03459/S (H4) ⁸	0.9km north-east of the route (80m from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	River Trent
T/07/03169/S (F8) ⁸	2km south-west of the route (0.11km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Bourne/Black/ Crane Brook
T/07/36041/S (F9) ⁸	2.2km south-west of the route (0.12km from the land required for construction of the Proposed Scheme)	WwTW/water collection/treatment/supply (Sewage)	Bourne Brook
T/07/36039/T (F9) ⁸	2.4km south-west of the route (0.11km from the land required for construction of the Proposed Scheme)	WwTW/water collection/treatment/supply (Sewage)	Bourne Brook
T/07/35372/S (E7) ⁸	0.94km south-west of the route (0.25km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Tributary of Bourne Brook
T/07/35304/S (F2) ⁸	1.96km north-east of the route (0.11km from the land required for construction of the Proposed Scheme)	WwTW (Sewage)	Tributary of the River Trent

⁸ Map WR-01-101. Discharges in the study area are listed from south to north.

Permit identifier (and map grid square)	Distance and direction from route	Discharge type	Receiving water body
NPSWQD007782 (E4) ⁸	0.65km north-east of the route (0.12km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Tributary of Crawley Brook
T/05/21739/O (B7) ⁸	0.91km south-west of the route (0.2km from the land required for construction of the Proposed Scheme)	Storm tank/combined sewage overflow on sewerage network (Sewage - water company)	Tributary of River Trent
T/06/35453/S (I4) ⁹	0.43km north-east of the route (0.26km from the land required for construction of the Proposed Scheme)	Education/nursery/school/college/university/training Venue (Sewage)	Tributary of the River Blithe
T/05/35342/S (I4) ⁹	0.45km north-east of the route (0.32km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Tributary of Coatfield Brook
DT/6362 (I4) ⁹	0.28km north-east of the route (0.13km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Receiving water not defined
T/05/0245/O (H9) ⁹	3.4km south-west of the route (adjacent to the land required for construction of the Proposed Scheme)	Storm tank/CSO on sewerage network (Sewage – water company)	River Trent
DT/3875 (I3) ⁹	0.77km north-east of the route (0.3km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Receiving water not defined
T/06/35198/S (I3) ⁹	0.81km north-east of the route (0.35km from the land required for construction of the Proposed Scheme)	WwTW (Sewage)	Tributary of the River Blithe
T/05/35447/S (E5) ⁹	0.8km south of the route (0.15km from the land required for construction of the Proposed Scheme)	Domestic property (single) (including farm house) (Sewage)	Moreton Brook

⁹ Map WR-01-102a. Discharges in the study area are listed from south to north.

Permit identifier (and map grid square)	Distance and direction from route	Discharge type	Receiving water body
T/05/35727/R (E2) ⁹	0.99km north of the route (70m from the land required for construction of the Proposed Scheme)	WwTW (Sewage - water company)	Tributary of the Moreton Brook

3.2 Groundwater

- 3.2.1 A summary of the geological units present in the Fradley to Colton area is presented in the Land Quality section in the Volume 2, Fradley to Colton area report, Section 10. The hydrogeological characteristics of the geological units are summarised in the Water resources and flood risk Volume 2, Fradley to Colton area report, Section 15. Further detail is provided in the following sections.
- 3.2.2 Map WR-02-201 (Volume 5: Water resources assessment and flood risk Map Book) shows the superficial and bedrock formations within the study area.
- 3.2.3 All Alluvium, River Terrace Deposits and Glaciofluvial Deposits in the study area are classified as Secondary A aquifers by the Environment Agency. Glacial Till has been classified as a Secondary Undifferentiated aquifer by the Environment Agency.
- 3.2.4 There are two bedrock aquifers in the study area. The Sherwood Sandstone Group is classified as a Principal aquifer and consists of the Helsby and Chester Formations. The Mercia Mudstone Group is classified as a Secondary B aquifer.
- 3.2.5 There are no Environment Agency observation boreholes which monitor groundwater level within the study area. There is one Environment Agency observation borehole at which groundwater quality is monitored, to the south of the Proposed Scheme at Rugeley Power Station.
- 3.2.6 No groundwater monitoring data is available for the Principal, Secondary A and Secondary B aquifers in the study area. Water strikes recorded on borehole logs have been referred to for the purpose of the assessment.
- 3.2.7 Groundwater in the superficial aquifers in the study area is expected to be shallow and the direction of groundwater flow is likely to follow the general topography. The surface watercourses are likely to act as discharge points for converging groundwater flow in the area.
- 3.2.8 Some groundwater flow is expected in the Mercia Mudstone Group, although permeable horizons within this unit are expected to be laterally discontinuous and associated with thin siltstone and sandstone layers called skerries. There may also be a small element of fracture flow.
- 3.2.9 Table 3 summaries groundwater abstractions and their locations are show on Map WR-02-201.
- 3.2.10 There is one groundwater abstraction licence for public water supply (PWS) near Hanch Hall Farm, at the southern end of the study area, protected by a source

protection zone (SPZ). The PWS is located approximately 2.2km to the south of the route. The SPZ₁ and SPZ₂ are broadly circular, both extending to the south-west, away from the Proposed Scheme.

- 3.2.11 There are nine private abstractions from groundwater (licensed and unlicensed) in the study area. These do not have mapped SPZs but, where used for potable supply and some other purposes, have a nominal SPZ₁ of 50m¹⁰. These abstractions have all been assessed as high value receptors.
- 3.2.12 The private water supply information has been provided by the local authorities, LDC and SBC. Where land access has been available, surveys have been undertaken to confirm abstraction details. Where the exact details of an abstraction are not known, a precautionary assessment has been undertaken.
- 3.2.13 There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m³ per day and not all unlicensed abstractions are registered with the local authority. These may also need to be protected.

Table 3: Summary of groundwater abstractions in the Fradley to Colton area

Name, licence number (and map grid square) ¹¹	Distance and direction from route	Abstraction source	Maximum annual abstraction quantity (m ³)	Maximum daily abstraction quantity (m ³)	Purpose	Number of boreholes
Public water supplies						
South Staffordshire Water Plc. Licence identifier confidential Map grid square: G7, G8, H7 and H8 (SPZ location)	2.2km south-west of the route of the Proposed Scheme (130m east of the land required for construction of the Proposed Scheme)	F51 Lichfield Unit (assumed to be Sherwood Sandstone Group)*	5,117,300	19,190	PWS, commercial and public services (water bottling)	2
Private licensed water supplies						
The Club Company (UK) Limited 03/28/07/0084 (G7)	2.2km south-west of the route of the Proposed Scheme (130m east of the land required for construction of the Proposed Scheme)	F51 Lichfield Unit (assumed to be Sherwood Sandstone Group)*	511,730	19,190	Food and drink (water bottling)	1

¹⁰ Environment Agency (2017), Protect groundwater and prevent groundwater pollution. Available online at: <https://www.gov.uk/government/publications/protect-groundwater-and-prevent-groundwater-pollution/protect-groundwater-and-prevent-groundwater-pollution>

¹¹ Map grid squares on Map WR-02-201 for SPZs, licence numbers (for licensed abstractions) and unique map identification (ID) numbers (for unlicensed groundwater abstractions). Abstraction features in the study area are generally listed from south to north.

Name, licence number (and map grid square) ¹¹	Distance and direction from route	Abstraction source	Maximum annual abstraction quantity (m ³)	Maximum daily abstraction quantity (m ³)	Purpose	Number of boreholes
G Baskerville & Co. 03/28/07/0008 (H5)	970m north-east of the route of the Proposed Scheme (100m east of the land required for construction of the Proposed Scheme)	U24T Minor aquifer - Upper Trent	9,950	27	General farming and domestic	1
Woodshoot Farm 03/28/07/0002 (H5)	1.2km north of the route of the Proposed Scheme (one inside the land required for construction, one 30m east of the land required for construction of the Proposed Scheme)	U24T Minor aquifer - Upper Trent	113,468	937	Agricultural (spray irrigation)	2
G&RM Roobottom 03/28/05/0050 (F5)	575m north-east of the route of the Proposed Scheme (80m north of the borrow pit at the north-east of the River Trent viaduct, between the River Trent and Pipe Lane)	U24T Minor aquifer - Upper Trent	13,600	500	Agricultural (spray irrigation but supplies a man-made fish stocked lake)	1
CM Froggatt & Sons MD/028/0005/002 (F5)	365m south-west of the route of the Proposed Scheme (180m south-west of the land required for construction of the Proposed Scheme)	F47 Hopton Unit (assumed to be the Sherwood Sandstone Group)*	18,500	1,000	Agricultural (spray irrigation)	1
RWE Generation UK PLC 03/28/05/0036 (E7)	3km south-west of the route of the Proposed Scheme (25m south of the land required for construction of the Proposed Scheme)	F47 Hopton Unit (assumed to be the Sherwood Sandstone Group)*	876,000	2,400	Water supply and production of energy (general feed and boiler supply)	2
Rugeley Power Station	3km south-west of the route of the	F47 Hopton Unit (assumed	1,392,840	3,816	Water supply and production of	2

Name, licence number (and map grid square) ¹¹	Distance and direction from route	Abstraction source	Maximum annual abstraction quantity (m ³)	Maximum daily abstraction quantity (m ³)	Purpose	Number of boreholes
03/28/05/0056 (D7)	Proposed Scheme (120m west of the land required for construction of the Proposed Scheme)	to be the Sherwood Sandstone Group [*]			energy (general feed and boiler supply)	
Parkinson Parkers 03/28/05/0046 (C4)	700m north of the route of the Proposed Scheme (75m east of the land required for construction of the Proposed Scheme)	U24T Minor aquifer - Upper Trent	8,295	23	General farming and domestic	1

Private unlicensed water supplies

Cawarden Springs Farm House Map ID: 1/GA/1 (E6)	135m north east of the route (40m from the land required for construction of the Proposed Scheme)	Unknown	Unknown	<20	Domestic and commercial	1
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^{*} Based on the information provided in the Staffordshire Trent Valley abstraction licensing strategy February 2013, Environment Agency. The Hopton Unit and Lichfield Unit are assumed to be part of the Sherwood Sandstone Group.

3.2.14 There are eight consented discharges to groundwater within the study area and these have been assessed as low value receptors. These are summarised in Table 4.

Table 4: Discharge consents to groundwater

Permit identifier (and map grid square) ¹²	Distance and direction from route	Discharge type	Receiving water body
3/28/07/1789 (I6)	950m north-east of the route of the Proposed Scheme (530m north-east of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata
3/28/07/1798 (I6)	950m north-east of the route of the Proposed Scheme (480m north-east of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata

¹² Map WR-02-201. Discharges in the study area are listed from south to north.

Permit identifier (and map grid square) ¹²	Distance and direction from route	Discharge type	Receiving water body
T5/05/3605/SG (H6)	770m south-west of the route of the Proposed Scheme (120m south-west of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata
T/07/36452/TG (H5)	1.2km north-east of the route of the Proposed Scheme (within the boundary of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata
3/28/05/2349 (F6)	930m south-west of the route of the Proposed Scheme (50m south of the land required for construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata
WQ/72/622 (F5)	525m south-west of the route of the Proposed Scheme (245m west of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata
3/28/05/2558 (E5)	370m south-west of the route of the Proposed Scheme (135m south-east of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata
3/28/05/2564 (C4)	Immediately north-east of the route of the Proposed Scheme (within the boundary of the land required for the construction of the Proposed Scheme)	Soakaway (domestic final/treated effluent)	Underground strata

3.3 Groundwater - surface water interaction

3.3.1 Table 5 summarises the potential groundwater - surface water interaction identified within the study area.

3.3.2 Along with the main surface watercourses, which could have connection with groundwater, potential springs and issues have been identified within the study area from Ordnance Survey (OS) maps. Where land access has been available, these have been surveyed to check if they are true expressions of groundwater (and therefore could contribute flows to surface water bodies), or if they are simply land drainage features. Where surveys have proved the latter, the features have been removed from the water resources assessment and they are not shown in the table below or on Map WR-02-201. In the absence of site surveys the features have been assumed to comprise springs and to be high value receptors.

Table 5: Groundwater - surface water interaction

Feature (and map grid square) ¹³	Distance and direction from route	Formation	Elevation (m AOD)	Comments
Watercourses				
Pyford Brook	Crossed by the route	Alluvium over Mercia Mudstone Group	62	These watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Ashby Sitch	Crossed by the route	Glaciofluvial Sheet Deposits over Mercia Mudstone Group	64	
Bourne Brook	Crossed by the route	River Terrace Deposits over Mercia Mudstone Group	64	
Crawley Brook	Crossed by the route	River Terrace Deposits over Mercia Mudstone Group	62.3	
River Trent	Crossed by the route	Alluvium over Mercia Mudstone Group	60.37	
Luth Burn	Crossed by the route	River Terrace Deposits over Mercia Mudstone Group	63.20	
Moreton Brook	Crossed by the route	Alluvium over Mercia Mudstone Group	80	
Springs				
Potential spring, Kings Bromley Wharf (H6)	725m south-west of the route of the Proposed Scheme (90m south-east of the land required for construction of the Proposed Scheme)	Glaciofluvial Deposits over Mercia Mudstone Group	70	Not surveyed. Assumed to be high value receptors.
Potential spring, Shaw Lane (G6)	385m south-west of the route of the Proposed Scheme (210m north-west of the land required for construction of the Proposed Scheme)	River Terrace Deposits over Mercia Mudstone Group	65	
Potential spring, Hill Ridware (E5)	710m south-west of the route (515m south-west of the land required for construction of the	Mercia Mudstone Group	66.71	

¹³ Map WR-02-201. Watercourses cross several map grid squares and are labelled. Map grid squares are provided for the springs and potential spring locations within the study area. These features are listed from south to north.

Feature (and map grid square) ¹³	Distance and direction from route	Formation	Elevation (m AOD)	Comments
	Proposed Scheme)			
Potential spring, near Blithbury West (E5)	Under the route of the Proposed Scheme	Mercia Mudstone Group	95	
Potential spring, Marlott Spinney (D5)	900m south-west of the route of the Proposed Scheme (590m west of the land required for construction of the Proposed Scheme)	Mercia Mudstone Group		
Potential spring, Blithbury Bank (D4)	370m north-west of the route, in the land required for construction of the Proposed Scheme)	Mercia Mudstone Group	100	
Potential spring, Park Barn Farm (C4)	550m north-east of the route of the Proposed Scheme (450m north-east of the land required for construction of the Proposed Scheme)	Mercia Mudstone Group	95	
Potential spring, Wilderley Barn (B4)	500m south-west of the route of the Proposed Scheme (300m south-west of the land required for construction of the Proposed Scheme)	Mercia Mudstone Group	92.5	
Potential spring, near Oakfields Farm, west of Admaston (i) (B4)	910m north-east of the route of the Proposed Scheme (620m north-east of the land required for construction of the Proposed Scheme)	Mercia Mudstone Group	100	
Potential spring, near Oakfields Farm, west of Admaston (ii) (B4)	940m north-east of the route of the Proposed Scheme (425m north-east of the land required for construction of the Proposed Scheme)	Mercia Mudstone Group	100	

3.4 Water dependent habitats

- 3.4.1 Lount Farm Local Wildlife Site (LWS) is crossed by the Proposed Scheme at the northern end of the study area. However, the area of marshland habitat within this wildlife site is located within the Colwich to Yarlet area. Impacts and effects related to this moderate value receptor have therefore been assessed within the Volume 2: Colwich to Yarlet area report within the section of the assessment on groundwater – surface water interaction.

4 Site specific surface water assessments

4.1 Summary of assessment

- 4.1.1 Table 6 summarises the potential impacts and effects related to surface water features, including watercourses, abstractions and discharges in the study area.
- 4.1.2 The WFD compliance assessment (Volume 5: Appendix WR-001-000) provides a comprehensive review of the aspects of the Proposed Scheme that have potential to cause permanent impacts on water bodies, or which could constrain the future achievement of water body objectives. Temporary construction impacts, defined as those which would last less than three years, may not have implications for WFD compliance, but may nevertheless result in significant effects related to water resources. Such temporary effects have therefore been considered in this assessment, as shown in Table 6.
- 4.1.3 The draft Code of Construction Practice (CoCP), referred to in Table 6, sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme (see Volume 5: Appendix CT-003-000). These will provide effective management and control of such impacts during the construction period.
- 4.1.4 The WFD compliance assessment identifies a number of permanent minor adverse impacts on water bodies within this study area. Minor impacts have been identified that affect Pyford Brook, the River Trent, Bourne Brook and Moreton Brook, all of which are high or very high value receptors. These significant effects are reported in the Water resources and flood risk Volume 2, Fradley to Colton area report, Section 15, together with the additional mitigation required. These permanent effects are not repeated in Table 6.
- 4.1.5 No potential for adverse impacts on the consented discharges to surface water listed in Table 2 have been identified.

Table 6: Summary of potential impacts on surface water receptors

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Watercourses									
River Trent	Very High	- Realignments - Watercourse crossing/viaducts and bridges.	Potentially affected by pollution caused by the mobilisation of contaminants by runoff from the construction area. Typically these would include sediments, hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact - Minor Significance of effect - Moderate adverse, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Pyford Brook Bourne Brook Moreton Brook	High	- Realignments - Watercourse crossing/viaducts and bridges.	Potentially affected by pollution caused by the mobilisation of contaminants by runoff from the construction area. Typically these would include sediments, hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact - Minor Significance of effect - Moderate adverse, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Crawley Brook Unnamed tributaries of the River Trent at Kings Bromley Tributary of the Bentley Brook at B5014 Uttoxeter Road Tributary of the Moreton Brook at Stockwell Heath	Moderate	- Realignments - Watercourse crossings/Culverts/drop inlet culverts.	Potentially affected by pollution caused by the mobilisation of contaminants by runoff from the construction area. Typically these would include sediments, hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact - Minor Significance of effect - Minor adverse, not significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Ashby Sitch Luth Burn Unnamed tributaries of the River Trent at Blithbury Tributaries of Moreton Brook	Low	- Realignments - Watercourse crossings/Culverts/drop inlet culverts.	Potentially affected by pollution caused by the mobilisation of contaminants by runoff from the construction area. Typically these would include sediments, hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact - Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction									
Surface water abstraction - Pyford Brook 03/28/07/0089 (H7 ²⁴)	High	- Pyford Brook viaduct	Located 0.72km upstream of viaduct and not within the land required for construction of the Proposed Scheme. There is a negligible risk of impacts occurring to this receptor.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the CoCP will be implemented throughout construction	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

²⁴ As shown on Map WR-01-101

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Surface water abstraction - Pyford Brook 03/28/07/0068 (H6 ¹⁴)	High	- Pyford Brook viaduct	Located 0.54km upstream of viaduct and not within the land required for construction of the Proposed Scheme. There is a negligible risk of impacts occurring to this receptor.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the CoCP will be implemented throughout construction	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction - Ashby Sitch 03/28/07/0040 (F4 ¹⁴)	High	- Pyford North embankment - Borrow pit at Kings Bromley South, located either side of Crawley Lane on the east and to the south of Ashby Sitch. - Kings Bromley Viaduct	Located 0.75km downstream of Pyford North embankment and 0.15km from the borrow pit. Potential impacts on water quality in Ashby Sitch during construction.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction – Bourne Brook 03/28/07/0040 (F4 ¹⁴)	High	- Pyford North embankment - Borrow pit at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road - Kings Bromley Viaduct	Located 0.75km downstream of Pyford North embankment. and adjacent to land required for construction Potential impacts on water quality in Bourne Brook during construction.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction - Bourne Brook 03/28/07/0040 (F3 ¹⁴)	High	- Pyford North embankment - Borrow pit at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road - Kings Bromley Viaduct	Located 0.92km downstream of Pyford North embankment and outside the land required for construction of the Proposed Scheme. Potential impacts on water quality in Bourne Brook during construction.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction - River Trent 03/28/05/0039 (E5 ¹⁴)	High	- Kings Bromley Viaduct - Bourne embankment - Borrow pit at Kings Bromley North, located adjacent to the realigned Shaw Lane.	Located 0.25km downstream, of Kings Bromley viaduct and within the land required for construction of the Proposed Scheme, adjacent to the borrow pit. Potential impacts on water quality in the River Trent during construction.	Magnitude of impact – Major Significance of effect – Major, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction - River Trent 03/28/07/0096 (D4 ¹⁴)	High	- River Trent Viaduct	Located 0.53km downstream of Kings Bromley viaduct and outside the land required for construction of the Proposed Scheme. Potential impacts on water quality in the River Trent during construction.	Magnitude of impact – Moderate Significance of effect – Moderate, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Surface water abstraction - River Trent 03/28/05/0057	High	- Grid supply point at Rugeley Power Station	Located adjacent to the land required for construction of the grid supply corridor between the route and Rugeley Power station.	Magnitude of impact – Moderate Significance of effect –	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect –	None required	Magnitude of impact – Negligible Significance of effect	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
(H8 ³⁵)			Potential impacts on water quality in the River Trent during construction.	Moderate, significant		Negligible, not significant		– Negligible, not significant	
Surface water abstraction - Moreton Brook MD/028/0005/003 (E515)	High	- Moreton South embankment	Located 0.71km downstream of Moreton South embankment and outside the land required for construction of the Proposed Scheme. Potential impacts on water quality in Moreton Brook during construction.	Magnitude of impact – Moderate Significance of effect – Moderate, significant	Implementation of measures described in the draft CoCP	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

³⁵ As show on Map WR-01-102a

5 Site specific groundwater assessments

5.1 Summary of assessment

- 5.1.1 Table 7 summarises all the potential impacts related to hydrogeology (aquifers), abstractions, groundwater-surface water interactions and groundwater dependent terrestrial ecosystems.
- 5.1.2 In Table 7, potential impacts on aquifers are grouped into those associated with above or at ground design elements, and those associated with significant excavation or construction of permanent below ground features. Potential impacts on other groundwater receptors such as abstractions, discharges and springs considered in the context of relevant design elements with a focus on those elements which have the potential to cause an impact.
- 5.1.3 Table 7 includes all consented discharges to groundwater within the area required for construction of the Proposed Scheme. It only includes those outside of this area where the potential for the Proposed Scheme to have an adverse impact on them has been identified. Impacts on the springs and potential spring features identified in Table 5 are only included in Table 7 where the potential for adverse impacts has been identified.
- 5.1.4 The potential impacts of future ground investigations are considered negligible because of the measures outlined in the draft CoCP. As this assessment is applicable for all receptors it is not re-stated in Table 7.
- 5.1.5 Further detail of several elements of the assessment is presented in Section 5.2.

Table 7: Summary of potential groundwater impacts

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Hydrogeology (groundwater)									
Sherwood Sandstone Group – Helsby Sandstone Formation – Principal aquifer	High	Construction of above ground elements and shallow excavation(<1m) including: - grid connection supply route from Newlands Lane auto transformer feeder station (ATFS) to Rugeley Power Station.	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be very localised and temporary. Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer so unlikely to affect groundwater flow or recharge. For impacts on abstraction and associated SPZ, see 'abstractions.'	Magnitude of impact – Minor Significance of effect – Moderate adverse, Significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Sherwood Sandstone Group – Helsby Sandstone Formation – Principal aquifer	High	Construction involving deeper excavation (>1m) below ground level (bgl) including: - Blithbury South cutting - Blithbury Central cutting	The temporary works have the potential to affect localised groundwater quality and flow. Impacts on the groundwater levels due to the cutting dewatering will be negligible in the context of the aquifer. See Section 5.2 for further details on cuttings. Temporary and permanent works are of small areal extent compared to the aquifer as a whole and so are unlikely to affect recharge.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Mercia Mudstone Group – Branscombe Mudstone Formation – Secondary B aquifer	Moderate (except where coincident with an SPZ ₁ where its value is 'very high,' see abstraction impacts)	Construction of above ground elements and shallow excavation (<1m) including: - Pyford South embankment - Pyford North embankment - Bourne embankment - Pipe Ridware embankment - Stockwell Heath embankment. - Inline raising of overhead 400kV overhead electricity line.	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be very localised and temporary. Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer so unlikely to affect groundwater flow or recharge. The in line raising of electricity line is within SPZ ₂ of PWS, however within the SPZ, works will only involve installation of earthing leads from the overhead cables near the tower down to ground level. There would be no piling or excavation work in the SPZ.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Mercia Mudstone Group – Branscombe Mudstone Formation – Secondary B aquifer	Moderate	Construction involving deeper excavation (>1m bgl) including: - Blithbury Central cutting	The temporary works have the potential to affect localised groundwater quality and flow. Impacts on the groundwater levels due to	Magnitude of impact – Minor Significance of effect – Minor adverse, not	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		<ul style="list-style-type: none"> - Blithbury North cutting - Stockwell Heath cutting - Pyford Brook viaduct - Kings Bromley viaduct - River Trent viaduct - Moreton Brook viaduct 	<p>the cutting dewatering will be negligible in the context of the aquifer. See Section 5.2 for further details on cuttings.</p> <p>Temporary and permanent works are of small areal extent compared to the aquifer so unlikely to affect recharge.</p> <p>Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of Mercia Mudstone Group, the impact on groundwater flow pathways will be negligible.</p>	significant		significant			
Glaciofluvial Sheet Deposits – Secondary A aquifer	Moderate	<p>Construction of above ground elements and shallow excavation (<1m) including:</p> <ul style="list-style-type: none"> - Pyford South embankment - Pyford North embankment 	<p>Temporary works have the potential to affect shallow groundwater quality although this is likely to be very localised and temporary.</p> <p>The temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer so unlikely to affect groundwater flow or recharge.</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Minor adverse, not significant</p>	Implementation of measures described in the draft CoCP.	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	None required	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	Construction (temporary and permanent)
Alluvium – Secondary A aquifer	Moderate	<p>Construction of above ground elements and shallow excavation (<1m) including:</p> <ul style="list-style-type: none"> - Stockwell Heath embankment 	<p>Temporary works have the potential to affect shallow groundwater quality although this is likely to be very localised and temporary.</p> <p>The temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer so unlikely to affect groundwater flow or recharge.</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Minor adverse, not significant</p>	Implementation of measures described in the draft CoCP.	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	None required	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	Construction (temporary and permanent)
Alluvium – Secondary A aquifer	Moderate	<p>Construction involving deeper excavation (>1m bgl) including:</p> <ul style="list-style-type: none"> - Moreton Brook viaduct - River Trent viaduct - Pyford Brook viaduct 	<p>Temporary works have the potential to affect localised groundwater quality however this is likely to be temporary.</p> <p>Temporary and permanent works are of small areal extent compared to the aquifer so unlikely to affect recharge.</p> <p>Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of alluvium, the impact on groundwater flow pathways will be negligible.</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Minor adverse, not significant</p>	Implementation of measures described in the draft CoCP.	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	None required	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	Construction (temporary and permanent)
River Terrace Deposits – Secondary A aquifer	Moderate	<p>Construction of above ground elements and shallow excavation (<1m)</p>	<p>Temporary works have the potential to affect shallow groundwater quality although this is likely to be very localised and</p>	<p>Magnitude of impact – Minor</p>	Implementation of measures described	<p>Magnitude of impact – Negligible</p>	None required	<p>Magnitude of impact – Negligible</p>	Construction (temporary and

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		including: - Bourne embankment - Pipe Ridware embankment	temporary. The temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer so unlikely to affect groundwater flow or recharge.	Significance of effect – Minor adverse, not significant	in the draft CoCP.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	permanent)
River Terrace Deposits – Secondary A aquifer	Moderate	Construction involving deeper excavation (>1m bgl) including: - Kings Bromley viaduct - River Trent viaduct	Temporary works have the potential to affect shallow groundwater quality although this is likely to be very localised and temporary. Temporary and permanent works are of small areal extent compared to the aquifer so unlikely to affect recharge. Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of River Terrace Deposits, the impact on groundwater flow pathways will be negligible.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

Abstractions

Licensed abstraction (PWS) South Staffordshire Water Plc. – 03/2/07/0097 License identified confidential (G7,G8,H7 and H8) ¹⁶	Very High	- In line raising of overhead 400kV overhead electricity line within the SPZ2. SPZ1 is located approximately 25m from the land required for construction of the Proposed Scheme.	Within the SPZ temporary and permanent works will only involve installation of earthing leads from the overhead cables near the tower down to ground level. There would be no piling or excavation work in the SPZ. Geology of the area indicates land required for construction is underlain by Mercia Mudstone Group. Abstraction is most likely from the Sherwood Sandstone Group underlying the Mercia Mudstone Group therefore limited pathway between the surface and aquifer. Overland flow path between the land required for construction and abstraction is intercepted by Bourne Brook. Therefore, no significant effect to groundwater from any potential above ground spills. Abstraction is outside the land required for construction so there will be no physical damage.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the CoCP will be implemented throughout construction	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Licensed abstraction The Club Company (UK) Limited - Maple Brook and Seedy Mill 03/28/07/0084 (G7) ¹⁶	High	- In line raising of overhead 400kV overhead electricity line 130m from the abstraction.	Temporary and permanent works will only involve the installation of earthing leads from the overhead cables near the tower down to ground level There will be no piling or excavation work in the vicinity of the abstraction. Geology of the area indicates land required for construction is underlain by Mercia Mudstone Group. Abstraction is most likely from the Sherwood Sandstone Group	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the CoCP will be implemented throughout construction	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

¹⁶ Map WR-02-201

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			underlying the Mercia Mudstone Group therefore limited pathway between the surface and aquifer.						
Licensed abstraction G Baskerville & Co – Common Lane Farm 03/28/07/0008 (H5 ¹⁶)	High	- Located 100m from utility diversion and associated works. - Located 600m from the borrow pit at Kings Bromley North, located adjacent to the realigned A414 Lichfield Road.	Nearby temporary and permanent works may affect groundwater quality. Excavation and dewatering of the borrow pit has the potential to affect groundwater quality and flow to the abstraction, although this is likely to be temporary. Further assessment of the potential effects of the borrow pit have been undertaken in Section 5.2. Nearby temporary and permanent works are above ground or shallow so unlikely to affect groundwater flow.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Additional ground investigation in the vicinity of the abstraction and borrow pit to determine appropriate additional mitigation (if required) and to inform design of the construction phase. Additional mitigation will be agreed with the landowner and may include an alternative water supply during the construction phase.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Licensed abstraction Woodshoot Farm (03/28/07/0002) (H5 ¹⁶)	High	- Utility diversion and associated works. - Located 630m north-east of the borrow pit at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road.	The licence is for two abstractions for spray irrigation. One abstraction is located within the area potentially used for construction of a utility diversion. Temporary works may affect groundwater quality and have the potential to physically damage the abstraction. Excavation and dewatering of the borrow pit has the potential to affect groundwater quality and flow to the abstraction, although this is likely to be temporary. Further assessment of the potential effects of the borrow pit have been undertaken in Section 5.2. Nearby temporary and permanent works are above ground or shallow so unlikely to affect groundwater flow.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Additional ground investigation in the vicinity of the abstraction and borrow pit to determine appropriate additional mitigation (if required) and to inform design of the construction phase. Additional mitigation will be agreed with the landowner and may include an alternative water supply during the construction phase.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Licensed abstraction G&RM Roobottom – Cowley Hall Farm 03/28/05/0050 (F5 ¹⁶)	High	- Located 80m north of the borrow pit north-east of the River Trent viaduct, between the River Trent and Pipe Lane.	Excavation and dewatering of the borrow pit has the potential to affect groundwater quality and flow to the abstraction although this is likely to be temporary. Further assessment of the potential effects of the borrow pit has been undertaken and is reported in Section 5.2.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Additional ground investigation in the vicinity of the abstraction and borrow pit to determine appropriate additional mitigation (if required) and to inform design of the construction phase. Additional mitigation	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
							will be agreed with the landowner and may include an alternative water supply during the construction phase.		
Licensed abstraction CM Forggatt & Sons – Luth Burn Pool Reservoir at Quintons Orchard Farm MD/028/0005/002 (F5 ¹⁶)	High	- Stockpile - Pipe Ridware embankment	Temporary works have the potential to affect shallow groundwater quality although this is likely to be very localised and temporary. The permanent works are above ground or shallow so unlikely to affect groundwater flow.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Licensed abstraction RWE Generation UK PLC – Rugeley Power Station 03/28/05/0036 (E7 ¹⁶)	High	- Horizontal directional drilling	Temporary works have the potential to affect shallow groundwater quality although this is likely to be very localised and temporary. Abstraction point located approximately 500m from the proposed underground cables.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Licensed abstraction Rugeley Power Limited - Rugeley Power Station 03/28/05/0056 (D7 ¹⁶)	High	- Horizontal directional drilling	This abstraction is located to the south of the cable works, and therefore likely up hydraulic gradient. It is located 25m south of the land required for construction. There is the potential for temporary earthworks to affect groundwater quality, although this is likely to be temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Licensed abstraction Parkinson Parkers – Lee Hall Farm 03/28/05/0046 (C4 ¹⁶)	High	- Area required for construction of the Proposed Scheme, likely for realignment of B5013 Uttoxeter Road	Temporary works have the potential to affect shallow groundwater quality, although this is likely to be very localised and temporary. Works are above ground or shallow so unlikely to affect groundwater flow.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Unlicensed private water supply Cawarden Springs Farm (E6 ¹⁶)	High	- Horizontal direction drilling to install underground cables which will be transferred to three overhead power lines via a cable sealing end compound south-west of Cawarden Springs Wood.	Temporary works have the potential to affect shallow groundwater quality, although this is likely to be very localised and temporary. The power line is above ground close to the abstraction. Underground drilling works are likely to be shallow in comparison to the likely depth of the borehole and therefore unlikely to affect groundwater flow.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary permanent)
Discharges to groundwater									
T/07/36452/TG	Low	- In line raising of overhead	The discharge is within the land required for	Magnitude of impact –	Implementation of	Magnitude of impact –	Mitigation proposals	Magnitude of impact –	Construction

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
(H5 ¹⁶)		400kV overhead electricity line	the construction of the Proposed Scheme. There is therefore potential for this featured to be damaged or lost.	Major Significance of effect – Minor adverse, not significant	measures described in the draft CoCP.	Major Significance of effect – Minor adverse, not significant	will be developed and discussed with the consent holder, with a view to an alternative discharge point being provided if required.	Negligible Significance of effect – Negligible, not significant	(temporary and permanent)
3/28/05/2564 (C4 ¹⁶)	Low	- Area allocated for planting	The discharge is within the land required for the construction of the Proposed Scheme. There is therefore potential for this featured to be damaged or lost.	Magnitude of impact – Major Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Major Significance of effect – Minor adverse, not significant	Mitigation proposals will be developed and discussed with the consent holder, with a view to an alternative discharge point being provided if required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

Groundwater – surface water interaction

Pyford Brook	High	- Pyford Brook viaduct	Temporary and permanent works have the potential to affect localised groundwater quality. Shallow groundwater flow may provide baseflow to Pyford Brook. Potential alterations of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifers, the impact on groundwater flow pathways will be negligible in context of baseflow to Pyford Brook.	Magnitude of impact – Minor Significance of effect - Moderate adverse Significant.	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect - Negligible, not significant.	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Ashby Sitch	Low	- Pyford North embankment. - Borrow pit located at Kings Bromley South, located either side of Crawley Lane on the east and to the south of Ashby Sitch.	Temporary works have the potential to affect localised groundwater quality however these effects will be temporary. Excavation, dewatering and restoration of the borrow pit has the potential to affect groundwater quality and flow in the area however these effects are likely to be temporary. Further assessment of the potential effects of the borrow pit have been undertaken in Section 5.2.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant.	Implementation of measures described in the draft CoCP. Implementation of borrow pit restoration strategy.	Magnitude of impact – Negligible Significance of effect - Negligible, not significant.	Ground investigation in the area around the borrow pit and to determine potential mitigation measures to prevent adverse changes in groundwater flow to and from the watercourse. See Section 5.2.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Bourne Brook	High	- Kings Bromley viaduct - Borrow pit at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road.	Shallow groundwater flow may provide baseflow to Bourne Brook. Temporary works have the potential to affect localised groundwater quality. Excavation, dewatering and restoration of the borrow pit has the potential to affect groundwater quality and flow in the area. Further assessment of the potential effects of the borrow pit have been undertaken in	Magnitude of impact – Moderate Significance of effect – Moderate adverse, Significant.	Implementation of measures described in the draft CoCP. A 50m buffer has been assigned around the brook, where no excavation will take place. Implementation of	Magnitude of impact – Moderate Significance of effect – Moderate, significant.	Ground investigation in the area around the borrow pit and to determine potential mitigation measures to prevent adverse changes in groundwater flow to and from the watercourse. See	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			<p>Section 5.2.</p> <p>Potential alterations of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifers, the impact on groundwater flow pathways will be negligible in context of baseflow to Bourne Brook.</p>		borrow pit restoration strategy.		Section 5.2.		
Crawley Brook	Moderate	<p>- Kings Bromley viaduct</p> <p>- Borrow pit located at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road.</p>	<p>Shallow groundwater flow may provide baseflow to Crawley Brook. Temporary works have the potential to affect localised groundwater quality.</p> <p>Excavation, dewatering and restoration of the borrow pit has the potential to affect groundwater quality and flow in the area. Further assessment of the potential effects of the borrow pit have been undertaken in Section 5.2.</p> <p>Potential alterations of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifers, the impact on groundwater flow pathways will be negligible in context of baseflow to Crawley Brook.</p>	<p>Magnitude of impact – Moderate</p> <p>Significance of effect – Moderate adverse, significant.</p>	<p>Implementation of measures described in the draft CoCP.</p> <p>A 50m buffer has been assigned around the brook, where no excavation will take place.</p> <p>Implementation of borrow pit restoration strategy.</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Minor, not significant.</p>	<p>Ground investigation in the area around the borrow pit to determine potential mitigation measures to prevent adverse changes in groundwater flow to and from the watercourse. See Section 5.2.</p>	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	Construction (temporary and permanent)
River Trent	Very high	<p>- River Trent viaduct</p> <p>- Borrow pit north-east of the River Trent viaduct, between the River Trent and Pipe Lane.</p>	<p>Shallow groundwater flow may provide baseflow to River Trent. Temporary works have the potential to affect localised groundwater quality.</p> <p>Excavation, dewatering and restoration of the borrow pit has the potential to affect groundwater quality and flow in the area. Further assessment of the potential effects of the borrow pit have been undertaken in Section 5.2. Potential alterations of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifers, the impact on groundwater flow pathways will be negligible in context of baseflow to the River Trent.</p>	<p>Magnitude of impact – Moderate</p> <p>Significance of effect – Major adverse, significant</p>	<p>Implementation of measures described in the draft CoCP.</p> <p>A 50m buffer has been assigned around the River Trent, where no excavation will take place.</p> <p>Implementation of borrow pit restoration strategy.</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Moderate adverse, significant.</p>	<p>Ground investigation in the area around the borrow pit to determine potential mitigation measures to prevent adverse changes in groundwater flow to and from the watercourse. See Section 5.2.</p>	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	Construction (temporary and permanent)
Luth Burn	Low	<p>- River Trent viaduct</p> <p>- Borrow pit north-east of the River Trent viaduct,</p>	<p>Shallow groundwater flow may provide baseflow to Luth Burn. Temporary works have the potential to affect localised</p>	<p>Magnitude of impact – Moderate</p> <p>Significance of effect –</p>	<p>Implementation of measures described in the draft CoCP.</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect –</p>	<p>Ground investigation in the area around the borrow pit and to</p>	<p>Magnitude of impact – Negligible</p> <p>Significance of effect –</p>	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		between the River Trent and Pipe Lane.	<p>groundwater quality.</p> <p>Excavation, dewatering and restoration of the borrow pit has the potential to affect groundwater quality and flow in the area although this is likely to be temporary. Further assessment of the potential effects of the borrow pit have been undertaken in Section 5.2.</p> <p>Potential alterations of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifers, the impact on groundwater flow pathways will be negligible in context of baseflow to Luth Burn.</p>	Minor adverse, not significant.	<p>A 50m buffer has been assigned around the River Trent, where no excavation will take place.</p> <p>Implementation of borrow pit restoration strategy.</p>	Minor, not significant.	determine potential mitigation measures to prevent adverse changes in groundwater flow to and from the watercourse. See Section 5.2.	Negligible, not significant	permanent)
Moreton Brook	High	- Moreton Brook viaduct	<p>Shallow groundwater flow may provide baseflow to Moreton Brook. Temporary works have the potential to affect localised groundwater quality.</p> <p>Potential alterations of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifers, the impact on groundwater flow pathways will be negligible in context of baseflow to Moreton Brook.</p>	<p>Magnitude of impact – Moderate</p> <p>Significance of effect – Moderate adverse, significant.</p>	Implementation of measures described in the draft CoCP.	<p>Magnitude of impact – Negligible</p> <p>Significance of effect - Negligible, not significant.</p>	None required	<p>Magnitude of impact – Negligible</p> <p>Significance of effect - Negligible, not significant.</p>	Construction (temporary and permanent)
Potential spring, Kings Bromley Wharf (H6 ¹⁶)	High	<p>- Pyford North embankment</p> <p>- Construction area for inline raising of electricity line</p>	Temporary and permanent works are above ground therefore construction is unlikely to affect water quality or groundwater flow to the spring.	<p>Magnitude of impact – Negligible</p> <p>Significance of effect - Negligible, not significant.</p>	None required though the CoCP will be implemented throughout construction	<p>Magnitude of impact – Negligible</p> <p>Significance of effect – Negligible, not significant</p>	None required	<p>Magnitude of impact – Negligible</p> <p>Significance of effect - Negligible, not significant.</p>	Construction (temporary and permanent)
Potential spring, near Blithbury West (E5 ¹⁶)	High	- Blithbury Central cutting	Temporary and permanent works may require diversion of this potential spring feature.	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Moderate adverse, significant.</p>	<p>Site survey to determine whether the spring is present.</p> <p>Implementation of measures described in the draft CoCP.</p> <p>Design of permanent structures will include groundwater control/drainage</p>	<p>Magnitude of impact – Minor</p> <p>Significance of effect – Moderate adverse, significant.</p>	If the spring is present, mitigation could include diversion and re-establishment of the spring elsewhere such that flows into downstream water bodies are not adversely impacted.	<p>Magnitude of impact – Negligible</p> <p>Significance of effect - Negligible, not significant</p>	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
					measures where required ³⁷ .				
Potential spring, Blithbury Bank (D4 ¹⁶)	High	- Hadley Gate diversion	Temporary and permanent works may require diversion of the potential spring and may affect groundwater flow to the spring and water quality.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant.	Site survey to determine whether the spring is present. Implementation of measures described in the draft CoCP. Design of permanent structures will include groundwater control/drainage measures where required. ³⁷	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant.	If the spring is present, mitigation could include diversion and re-establishment of the spring elsewhere such that flows into downstream water bodies are not adversely impacted.	Magnitude of impact – Negligible Significance of effect - Negligible, not significant.	Construction (temporary and permanent)

³⁷ Groundwater control/drainage measures are outlined in Volume 2, Fradley to Colton area report, Section 15 and Volume 5, WFD compliance assessment, Appendix WR-001-000. These measures will be designed in detail, where required, following ground investigation and monitoring. They may include, for example, passive hydraulic bypasses at cuttings and other below ground structures or use of soakaways to promote local aquifer recharge.

5.2 Detailed assessment

5.2.1 In support of the impact assessment presented in Table 7, further detail is provided in this section to demonstrate the methodology and assumptions used in relation to specific design elements and locations along the Proposed Scheme. Within the Fradley to Colton study area detailed assessments are presented demonstrating the likely impacts on groundwater from several cuttings and borrow pits.

Impact on groundwater from cuttings

5.2.2 The location of cuttings is shown in Volume2: Map Series CT-05 and Map Series CT-06. The cuttings which intersect aquifers have been initially characterised to determine whether groundwater elevations are likely to be above the base of the cutting. Parameters for the groundwater assessment of the cuttings are shown in Table 8 to Table 11. Where the groundwater elevation is not known, or where the elevation has been found to be above the base of the cutting, a further detailed assessment of the likely maximum zone of influence from dewatering of the cutting has been undertaken.

Initial characterisation of cuttings

Blithbury South cutting

Table 8: Summary of the Blithbury South cutting parameters for the groundwater assessment

Cutting parameters	Parameter details
Length (km)	0.96
Maximum depth (m)	5
Strata intercepted	Sherwood Sandstone Group (Principal aquifer) Mercia Mudstone Group (Secondary Undifferentiated aquifer)
Lowest track level (metres above ordnance datum: mAOD)	78.6
Groundwater level(s) (mAOD)	68 to 73 based on Coal Exploration boreholes SK01NE14 and SK01NE56 or 7-9m bgl (SK01NE80)
Principal receptors	Sherwood Sandstone Group Principal aquifer

5.2.3 The cutting would penetrate the Sherwood Sandstone Group Principal aquifer in an area where the maximum recorded groundwater levels or depth to groundwater is below the cutting. Groundwater flow will therefore not be disrupted and no further assessment has been undertaken. The residual thickness of unsaturated zone will provide some attenuation of seepage from the cutting. Application of the CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

Blithbury Central cutting

Table 9: Summary of the Blithbury Central cutting parameters for the groundwater assessment

Cutting parameters	Parameter details
Length (km)	2.1
Maximum depth (m)	8
Strata intercepted	Glacial Till (Secondary Undifferentiated aquifer) Mercia Mudstone Group (Secondary B aquifer)
Lowest track level (mAOD)	87.5
Groundwater level(s) (mAOD)	No currently available information
Principal receptors	Mercia Mudstone Group Potential spring near Blithbury West – potential spring is located beneath the route of the Proposed Scheme.

- 5.2.4 As there is no currently available information on groundwater elevations or depth to groundwater in this area, it has conservatively been assumed that the groundwater flow within the Mercia Mudstone Group may be affected by the cutting. Further assessment is demonstrated in the following section (cuttings below rest groundwater level, assessment). Application of the CoCP will ensure materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

Blithbury North cutting

Table 10: Summary of the Hatton South Cutting parameters for the groundwater assessment

Cutting parameters	Parameter details
Length (km)	0.895
Maximum depth (m)	12
Strata intercepted	Glacial Till (Secondary Undifferentiated aquifer) Mercia Mudstone Group (Secondary B aquifer)
Lowest track level (mAOD)	97.2
Groundwater level(s) (mAOD)	No currently available information

Cutting parameters	Parameter details
Principal receptors	Mercia Mudstone Group Secondary B aquifer

- 5.2.5 As there is no currently available information on groundwater elevations or depth to groundwater in this area, it has conservatively been assumed that the groundwater flow within the Sherwood Sandstone Group and the Mercia Mudstone Group may be affected by the cutting. Further assessment is demonstrated in the following section (cuttings below rest groundwater level, assessment). Application of the CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

Stockwell Heath cutting

Table 11: Summary of the Stockwell Heath Cutting parameters for the groundwater assessment

Cutting parameters	Parameter details
Length (km)	0.555
Maximum depth (m)	8
Strata intercepted	Mercia Mudstone Group (Secondary B aquifer)
Lowest track level (mAOD)	89.9
Groundwater level(s) (mAOD)	No currently available information
Principal receptors	Mercia Mudstone Group (Secondary B aquifer)

- 5.2.6 As there is no currently available information on groundwater elevations or depth to groundwater in this area, it has conservatively been assumed that the groundwater flow within the Sherwood Sandstone Group and the Mercia Mudstone Group may be affected by the cutting. Further assessment is demonstrated in the following section (cuttings below rest groundwater level, assessment). Application of the CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

Assessment of cuttings below groundwater level

- 5.2.7 Assessment of the likely maximum zone of influence from dewatering of the cuttings which may be below existing groundwater level (as set out above) has been made using Sichardt's formula.
- 5.2.8 The methodology follows the Environment Agency guidance¹⁸ and the methodology set out in CIRIA C750¹⁹, as summarised in the SMR Addendum, Volume 5: Appendix CT-001-002).
- 5.2.9 Sichardt's formula is presented below:

¹⁸ Environment Agency (2007), *Hydrogeological impact appraisal for dewatering*

¹⁹ Preene, M., Roberts, T.O.L. and Powrie, W. (2016), *Groundwater control: design and practice*. CIRIA Publication C750

$$L_o = C \times h \times \sqrt{k}$$

Where; L_o = distance of influence from linear structure (m)

k = hydraulic conductivity (m/s)

h = drawdown (m)

C = empirical calculation factor taken to be 1750²⁰

- 5.2.10 Hydraulic conductivity values from the high end of the range, presented in literature, have been used in the assessment, to provide a conservative estimate of the dewatering zone of influence. Where groundwater levels are not known, the worst case assumption, that groundwater is at ground level, has been used.
- 5.2.11 Due to the limited information available it was assumed that the Glacial Till, classified as a Secondary Undifferentiated aquifer, would have similar conductivity as the underlying Mercia Mudstone Group. The potential effect of dewatering the Glacial Till, where present, as a separate strata, was therefore not considered.
- 5.2.12 Where the assessment of the zone of influence has been undertaken, cuttings are assumed to be open and any permanent works such as retaining walls or drainage measures do not form part of the quantitative assessment.
- 5.2.13 Based on these precautionary assumptions, the zone of influence is likely to be overestimated. However, for the purpose of this preliminary assessment, this precautionary approach is considered to be appropriate.

Blithbury Central cutting

- 5.2.14 Assuming a hydraulic conductivity value of $1 \times 10^{-6} \text{ m/s}^{21}$ for both the Glacial Till and the Mercia Mudstone Group, the maximum zone of influence from the cutting is 14.7m. This is based on a maximum cutting depth of 8m and a rest water level at ground level. The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore dewatering of the cutting is assessed as having a negligible impact.
- 5.2.15 There are likely to be thin groundwater bearing units within the Mercia Mudstone Group which may not be laterally extensive. Whilst borehole logs in the general area do not indicate such units in the top 8m, further ground investigation and monitoring is required to confirm groundwater levels in this location, and whether there are any skerry bands likely to be affected by the cutting. This will inform the detailed design and management of groundwater during construction.
- 5.2.16 The potential spring near Blithbury West is located beneath the route of the Proposed Scheme at the Blithbury Central cutting. If the site survey shows that the spring is present it will therefore be adversely impacted by the cutting. Mitigation could include diversion and re-establishment of the spring elsewhere such that flows into downstream water bodies are not adversely impacted. There are no other recorded groundwater dependant features within the calculated zone of influence.

²⁰ Cashman, P.M. and Preene. M. (2001), *Groundwater Lowering in Construction, a Practical Guide*

²¹ Based on the high end value for bulk testing within the Mercia Mudstone Group. Engineering geology of British rocks and soils, Mudstones of the Mercia Mudstone Group RR/01/02

- 5.2.17 Application of the CoCP pollution prevention measures and the drainage design will ensure that any impacts on groundwater quality are negligible.

Blithbury North cutting

- 5.2.18 Assuming a hydraulic conductivity value of $1 \times 10^{-6} \text{ m/s}^{22}$ for the Mercia Mudstone Group, the maximum zone of influence from the cutting is 22m. This is based on a maximum cutting depth of 12m and a rest water level at ground level. The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore dewatering of the cutting is assessed as having a negligible impact.
- 5.2.19 There are likely to be thin groundwater bearing units within the Mercia Mudstone Group which may not be laterally extensive. Whilst borehole logs in the general area do not indicate such units in the top 12m, further ground investigation and monitoring is required to confirm groundwater levels in this location, and whether there are any skerry bands likely to be affected by the cutting. This will inform the detailed design and management of groundwater during construction.
- 5.2.20 There are no recorded groundwater dependant features within the calculated zone of influence.
- 5.2.21 Application of the CoCP pollution prevention measures and the drainage design will ensure that any impacts on groundwater quality are negligible.

Stockwell Heath cutting

- 5.2.22 Assuming a hydraulic conductivity value of $1 \times 10^{-6} \text{ m/s}^{22}$ for both the Glacial Till and the Mercia Mudstone Group, the maximum zone of influence from the cutting is 14.7m. This is based on a maximum cutting depth of 8m and a rest water level at ground level. The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore dewatering of the cutting is assessed as having a negligible impact.
- 5.2.23 There are likely to be thin groundwater bearing units within the Mercia Mudstone Group which may not be laterally extensive. Whilst borehole logs in the general area do not indicate such units in the top 8m, further ground investigation and monitoring is required to confirm groundwater levels in this location and whether there are any skerry bands likely to be affected by the cutting. This will inform the detailed design and management of groundwater during construction.
- 5.2.24 There are no recorded groundwater dependant features within the calculated zone of influence.
- 5.2.25 Application of the CoCP pollution prevention measures and the drainage design will ensure that any impacts on groundwater quality are negligible.

²² Based on the high end value for bulk testing within the Mercia Mudstone Group. Engineering geology of British rocks and soils, Mudstones of the Mercia Mudstone Group RR/01/02

Impacts to groundwater from borrow pits

- 5.2.26 There are four borrow pits within the Fradley to Colton study area as shown in Table 12. The borrow pits will be used to extract sand and gravel with which to construct embankments. Maximum and indicative average depths for each borrow pit are presented in Table 12.

Table 12: Extraction depths of borrow pits

Location	Assumed average extraction depth (m)	Maximum extraction depth (m)
Kings Bromley South, located either side of Crawley Lane on the east and to the south of Ashby Sitch	4.1	12.8
Kings Bromley North, located adjacent to the realigned A515 Lichfield Road	4.1	8.8
Kings Bromley North, located adjacent to the realigned Shaw Lane	4.3	8.8
North-east of the River Trent viaduct, between the River Trent and Pipe Lane	11.1	15.8

- 5.2.27 The excavations will be through the River Terrace Deposits or Glaciofluvial Sheet Deposits, both Secondary A aquifers, and therefore have the potential to impact on the Secondary A aquifers and receptors which rely on them as a water resource. Receptors include Ashby Sitch, Bourne Brook, Crawley Brook, River Trent and Luth Burn, a licensed private groundwater abstraction at Cowley Hall Farm, located approximately 80m north of the borrow pit north-east of the River Trent viaduct, between the River Trent and Pipe Lane, as well as two licensed groundwater abstractions located at Woodshoot Farm and Common Lane Farm, 630m and 600m respectively from the borrow pit at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road.
- 5.2.28 There is no groundwater level monitoring the vicinity of the borrow pits. It is therefore conservatively assumed that groundwater levels within the River Terrace Deposits and Glaciofluvial Deposits are shallow. It is also assumed that the shallow groundwater is in hydraulic continuity with the surface water features.

Temporary construction impacts to groundwater and associated receptors from the borrow pits

- 5.2.29 It is assumed that during excavation of the sand and gravels, dewatering will be undertaken to allow for safe working. The measures outlined in the draft CoCP will be implemented throughout the works to manage drainage and protection of water quality. Dewatering of the excavations may reverse the hydraulic gradient between the aquifer and surface water features and without additional mitigation the surface water bodies could lose water to the ground. This would result in a minor impact, and, in the case of high or very high value receptors (Bourne Brook and the River Trent), a moderate short term (significant) effect.

- 5.2.30 Ground investigation and pre-construction monitoring of the Secondary A aquifer and the nearby surface water features will be undertaken, to inform construction mitigation measures which will protect the surface water features from loss of water. The type of mitigation measures could include: -
- widening the buffer strip between the borrow pit and surface water feature;
 - recirculate abstracted water back into local watercourses to maintain flows at the appropriate locations;
 - installation of cut-off structures around excavations;
 - ensuring that cut-off structures are driven to sufficient depths to meet an underlying strata or zone of lower permeability;
 - promotion of groundwater recharge, such as discharging pumped water to recharge trenches around excavations to maintain baseline groundwater and surface water conditions; and
 - incorporation of passive bypasses within the design, which could comprise a 'blanket' of permeable material, such as gravel, placed around temporary structures allowing groundwater to bypass the below-ground works, without a rise in groundwater levels on the upstream side.
- 5.2.31 The licensed groundwater abstraction at Cowley Hall Farm is approximately 80m from the construction of the borrow pit north-east of the River Trent viaduct, between the River Trent and Pipe Lane. The abstraction is to supply a man-made pond which is currently used for recreational fishing. The water may be used for irrigation in dry season and the current landowners have a licence to sell water to neighbours. The abstraction horizon is listed in the licence as 'U24T Minor aquifer - Upper Trent.' The abstraction is likely to be from the River Terrace Deposits as the underlying bedrock is the Mercia Mudstone Group. With the implementation of the CoCP, the effects on the water quality at the abstraction are assessed as negligible, not significant however, dewatering of the borrow pit area may result in a reduction of groundwater flow to the abstraction, as well as reducing the water level within the man-made pond. Additional mitigation will be proposed following ground investigation and pre-construction monitoring of the Secondary A aquifer in the vicinity of the abstraction. The design of mitigation measures would be discussed with the landowner.
- 5.2.32 There are two licensed groundwater abstractions at in the vicinity of the borrow pit at Kings Bromley North, located adjacent to the realigned A515 Lichfield Road. The abstractions are located at Woodshoot Farm, 630m from the borrow pit, licensed for spray irrigation, and at Common Lane Farm, 600m from the borrow pit, licensed for general farming and domestic use. The abstraction horizon is listed in both licences as 'U24T Minor aquifer - Upper Trent.' The abstractions are therefore likely to be from the River Terrace Deposits as the underlying bedrock is the Mercia Mudstone Group. With the implementation of the CoCP, the effects on the water quality at the abstractions are assessed as negligible, not significant however, dewatering of the borrow pit area may result in a reduction of groundwater flow to the abstraction. Additional mitigation will be proposed following ground investigation and pre-construction monitoring of the Secondary A aquifer in the vicinity of the abstraction. The design of mitigation measures would be discussed with the landowner.

- 5.2.33 The exact requirements will be refined and method of mitigation will be designed following ground investigation at cutting locations. Mitigation measures will be designed in consultation with the Environment Agency.

Permanent construction impacts to groundwater and associated receptors from the borrow pits

- 5.2.34 The borrow pits will be restored to current ground levels and land use. As it is assumed that the area of permeable sand and gravel will be replaced with material of lower permeability the restoration plans will include land drainage measures to ensure no groundwater flooding up gradient of the infilled sites, and continued water discharge to the surface water features. The details of this design will be outlined following ground investigation and monitoring of the hydraulic gradient across the borrow pit areas, and hydrometric monitoring of the appropriate surface water features. The resulting permanent effect of the Proposed Scheme on the surface water features and the groundwater abstractions due to the borrow pit areas will be negligible (not significant).
- 5.2.35 The permanent loss of these area of Secondary A aquifers is assessed as a negligible (not significant) effect because the sand and gravels do not form part of the main WFD groundwater body in this area (the Manchester and East Cheshire Carboniferous Aquifers, see WFD compliance assessment, Volume 5, Appendix WR-001-000) and mitigation will be embedded in the design and construction methodology to protect the surface water receptors of importance for which the Secondary A aquifer may provide a source of baseflow.

6 Site specific highways drainage assessments

6.1 Introduction

- 6.1.1 The majority of highway works comprise minor realignments, with no significant increase in impermeable paved areas. The Proposed Scheme makes provision for two methods for draining these new sections of highway: direct runoff to soakaway and drainage via an attenuation pond to an existing watercourse. An assessment has been made of whether the highway works proposed have implications for pollution risk within the Fradley to Colton area.

6.2 Methodology and assessment criteria

Routine runoff pollution risk

- 6.2.1 Where highway drainage is discharged to local watercourses, the assessment for determining whether routine runoff is likely to have a detrimental impact on water quality uses Highways England's (HE) (formerly Highways Agency) Water Risk Assessment Tool (HAWRAT), Method A in Volume 11, Section 3, Part 10 HD 45/09 of the Design Manual for Roads and Bridges (DMRB). Where highway realignments are to discharge to curb side ditches which do not have a baseflow, the Groundwater Assessment (Method C) in Volume 11, Section 3, Part 10 HD 45/09 of the DMRB has been used.
- 6.2.2 The significance of the impact of the predicted effects on surface water and groundwater receptors has been assessed in accordance with the methodology described in the SMR, Volume 5: Appendix CT-001-001.

Spillage pollution risk

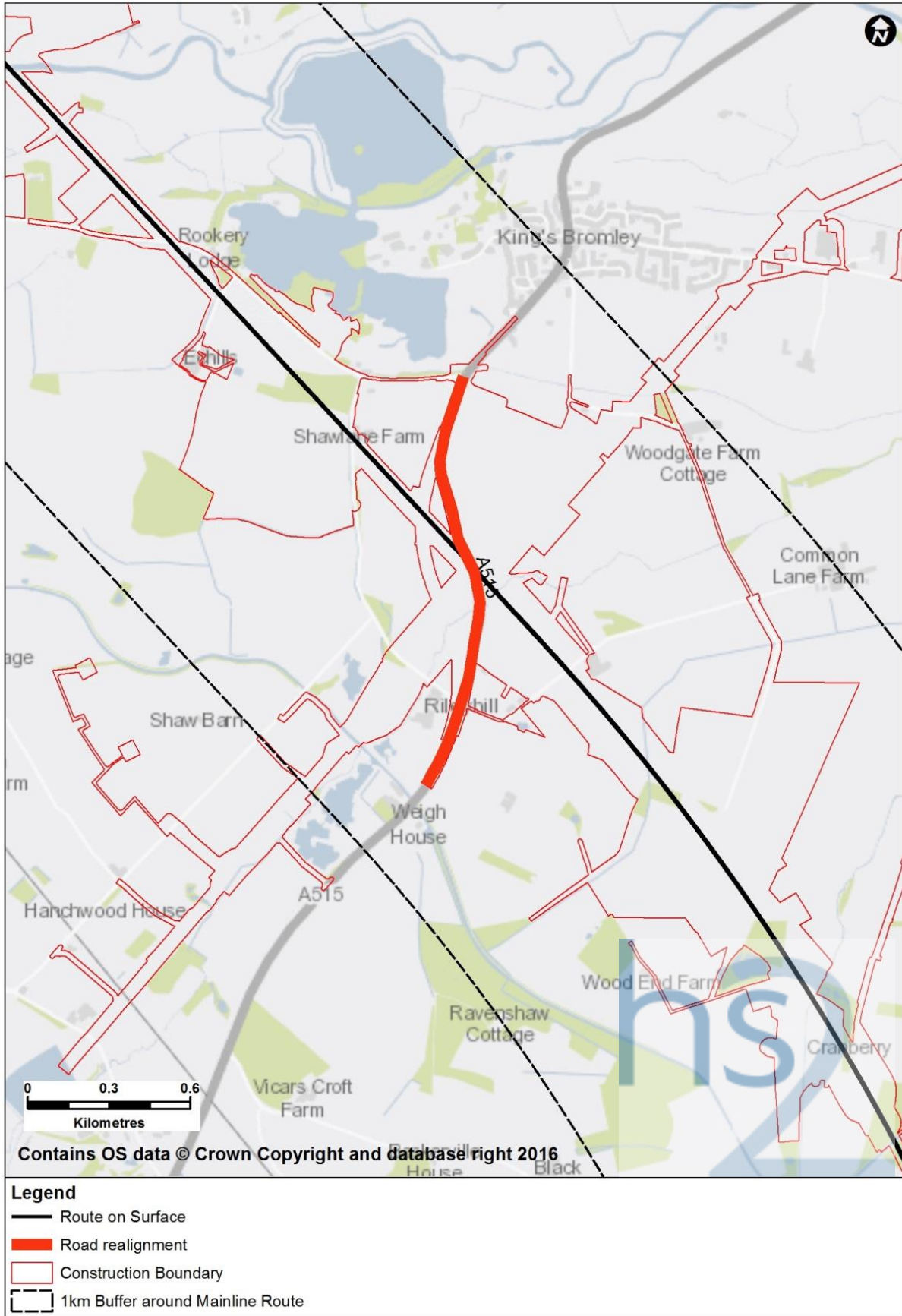
- 6.2.3 In addition to assessing the potential for adverse effects of routine surface water runoff from highways, an assessment of the potential spillage risk to water quality must also been undertaken qualifying highway realignment. The methodology for assessing spillage risk follows the Spillage Risk Assessment (Method D) presented in Volume 11, Section 3, Part 10 HD 45/09 of the DMRB.

6.3 Assessments

Screening Results

- 6.3.1 A screening exercise identified the need for a routine runoff and a pollution risk assessment in the Fradley to Colton area. This is related to the modifications to the A515 Lichfield Road shown in Figure 1.

Figure 1: A515 Lichfield Road Realignment



Routine runoff pollution risk

- 6.3.2 The modification to the A515 Lichfield Road between Kings Bromley and Lichfield involves the realignment of the carriageway along a total length of 1.45km and complete replacement of the existing drainage. The road passes over the flat landscape of the Bourn Brook floodplain and it is proposed to construct like for like highway drainage comprising kerbside linear gully drains that will soak away to ground water.
- 6.3.3 The assessment results identified that the magnitude of the impacts of routine runoff from this proposed highway realignment would be negligible. The receptors are of moderate value. The proposal will therefore not result in significant effects. This highway realignment falls into the medium risk category. The DMRB guidance suggests that a precautionary approach should be adopted in such circumstances and additional measures may be required to mitigate the risk of deterioration in groundwater quality. Such measures would be considered at the detailed design stage in consultation with the relevant highway authority.

Highways spillage risk assessment

- 6.3.4 The evaluation of spillage risk for the A515 Lichfield Road is presented in Table 13 below. The risk of a serious pollution incident occurring is identified to be negligible. The highway realignment will not result in significant effects related to spillage risk and no further mitigation is required.

Table 13: Spillage risk assessment for A515 Lichfield Road²³

Water body type	Surface water	Notes
Length of road draining to outfall (km)	1.45	The length of the road was measured based on CP2+ general arrangement drawings.
Road Type (A-road or Motorway)	A	
If A road, is site urban or rural?	Rural	
Junction type	No Junction	
Location	< 1 hour	A response time of less than 1 hour is expected for emergency services to reach the source of the groundwater pollution incident.
Traffic flow (AADT (annual average daily traffic) two way)	50,000	The traffic flow (AADT two way) upper limit of 50,000 was used to represent the worst case scenario.
% HGV (heavy goods vehicle)	1	The percentage of HGV traffic was selected from the AADT HGV hotspot situated nearest to the A515 Lichfield Road alteration.
Spillage factor (no/109HGVkm/year)	0.88	The spillage factor was taken from Table D1.1 as presented in Volume 11, Section 3, Part 10 HD 45/09 of the DMRB.

²³This table provides a summary of the spillage risk calculations carried out using the HAWRAT spillage risk spreadsheet, <http://www.hagdms.com/index.cfm?fuseaction=help.download>

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Water body type	Surface water	Notes
Risk of accidental spillage	0.0002%	This represents the total annual probability of a spillage.
Risk of pollution incident	0.01%	This represents the total annual probability of a spillage causing a pollution incident.
Is risk greater than 0.01?	N	This is the considered overall risk for the length of the A515 Lichfield Road realignment.

7 References

- British Geological Survey (1997), *The physical properties of major aquifers in England and Wales*, Technical Report WD/97/34, Environment Agency R&D Publication 8.
- British Geological Survey (2002), *Engineering geology of British rocks and soils, Mudstones of the Mercia Mudstone Group*, Research Report RR/01/02.
- Cashman, P.M. and Preene, M. (2001), *Groundwater Lowering in Construction, a Practical Guide*.
- Design Manual for Roads and Bridges Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 10, HD45/09 "Road Drainage and the Water Environment".
- Domenico, P. A. and Schwartz, F. W. (1990), *Physical and chemical hydrogeology*. John Wiley & Sons.
- Environment Agency (2007), *Hydrogeological impact appraisal for dewatering abstractions*.
- Environment Agency (2017), *Protect groundwater and prevent groundwater pollution*. Available online at: <https://www.gov.uk/government/publications/protect-groundwater-and-prevent-groundwater-pollution/protect-groundwater-and-prevent-groundwater-pollution>
- HS2 Ltd (2017), *High Speed 2 (HS2) Phase 2a (West Midlands - Crewe), Background Information and Data, Hydraulic Modelling Reports*. Available online at: www.gov.uk/hs2
- Lewis, M. A., Cheney, C. S. and O'Douchartaigh, B. E. (2006) *Guide to permeability indices*. British Geological Survey Open Report, CR/06/160N. 29pp.
- Preene, M., Roberts, T.O.L. and Powrie, W. (2016), *Groundwater control: design and practice*. CIRIA Publication C750.

