In Parliament – Session 2021 - 2022

HS2

High Speed Rail (Crewe – Manchester)

Background information and data

Water resources and flood risk

BID WR-004-0MA07

MA07: Davenport Green to Ardwick

Water resources assessment baseline data

M321

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Department for Transport

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1.1.1 This document presents baseline data relating to the water resources assessment that has been undertaken for the Proposed Scheme.

1.1.2 The data has been collected in relation to the Davenport Green to Ardwick area (MA07).

1.1.3 The Environmental Statement[1] should be referred to for details of:

- the Water Framework Directive (WFD) assessment (Volume 3, Route-wide effects and Volume 5: Appendix WR-001-00000);
- the water resources assessments and flood risk assessments that are reported per community area (Volume 5: Appendices WR-003-0MA07 and WR-005-0MA07);
- the hydraulic modelling reports that support the flood risk assessments (Volume 5: Appendix WR-006-00009); and
- a Draft water resources operation and maintenance plan (Volume 5: Appendix WR-007-00000).

1.1.4 Additional information is also included in Background Information and Data (BID) WFD compliance assessment baseline data that is reported for the Proposed Scheme (BID WR-002-00001).

1.1.5 Maps referred to throughout this document are set out in Volume 5, Water resources and flood risk Map Book: Map Series WR-01 and WR-02[2].

1.1.6 The Environmental Impact Assessment Scope and Methodology Report (SMR)[3] states that the spatial scope of the assessment (the study area) should be based upon the identification of surface water and groundwater features within 500m of the route of the Proposed Scheme, in urban area. In the Davenport Green to Ardwick area, the study area has been extended to include the zone of influence of tunnel construction on groundwater (up to 1.5km from the vent shaft sites).

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Environmental Statement*. Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

[2] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Environmental Statement, Volume 5 Water resources and flood risk Map Book*. Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

[3] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Environmental Statement, Environmental Impact Assessment Scope and Methodology Report*, Volume 5, Appendix CT-001-00001. Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

2 Baseline data

2.1 Surface water

2.1.1 The surface water features potentially affected by the Proposed Scheme, including their location, current overall WFD status, and future overall status objectives, are shown in Table 1; further details are set out in the Water Framework Directive compliance assessment baseline data (BID WR-002-00001). The receptor values attributed to each individual watercourse, based on the methodologies set out in the SMR[3], are also provided.

2.1.2 Those surface water features potentially affected by groundwater interactions are described separately in Section 2.3.

Table 1: Surface water body receptors

Water body name and location[4]	Type (at point closest to the Proposed Scheme)[5]	Q95 value (m^3/s)[6]	Receptor value	Parent WFD water body name and identification number[7]	Current WFD status/ objective[8]	2019 WFD status
Fairywell Brook WR-01-309b – E5	Main river	0.004	Low	Sinderland Brook (Fairywell Brook and Baguley Brook) GB112069061270	Moderate/ Good by 2027	Moderate
Baguley Brook WR-01-309b – G4	Main river	0.01	Moderate			
Mill Brook WR-01-309b – F5	Ordinary watercourse	<0.002	Moderate			
Tributary of Baguley Brook WR-01-309b – G5	Ordinary watercourse	<0.002	Low			
Round Wood Drain WR-01-309b – H5	Minor ditch	N/A	Low			

[4] The feature locations are indicated by the grid coordinates on the relevant Volume 5, Water resources and flood risk Map Book: Map Series WR-01.

[5] The term 'minor ditch' has been used to denote a small trench or drain that has been constructed for the purpose of draining water from the land or roads and is isolated from the wider river network.

[6] This is the flow within the watercourse that is exceeded for 95% of the time. The Q95 has been provided as an indication of watercourse size but is only one of several criteria used to inform receptor value. Other criteria include the WFD watercourse classification which takes into account the value of any habitat which the watercourse supports. Details are provided in the SMR.

[7] The Environment Agency has attributed each surface water and groundwater body a unique water body identification (ID) number.

[8] Status and objectives are based on those set out in the 2015 river basin management plan (RBMP). Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/718335/North_West_RBD_Part_1_river_basin_management_plan.pdf.

Water body name and location[4]	Type (at point closest to the Proposed Scheme)[5]	Q95 value (m^3/s)[6]	Receptor value	Parent WFD water body name and identification number[7]	Current WFD status/ objective[8]	2019 WFD status
River Mersey WR-01-309b – I8	Main river	1	Very high	Mersey (upstream of the Manchester Ship Canal) GB112069061030	Moderate/ Moderate by 2015	Moderate
Tributary of River Mersey 1 WR-01-309b – I6	Ordinary watercourse	<0.002	Moderate			
M60 Drainage WR-01-309b – I5	Minor ditch	0.004	Moderate			
Tributary of River Mersey 3 WR-01-310a – B4	Ordinary watercourse	<0.002	Moderate			
Tributary of River Mersey 2 WR-01-310a – B4	Main river	<0.002	Moderate			
Red Lion Brook WR-01-310a – C6	Ordinary watercourse	<0.002	Low	Chorlton Brook (Princess Parkway to Mersey) GB112069061040	Moderate/ Good by 2027	Moderate
Shaw Brook WR-01-310a – D5	Minor ditch	<0.002	Low			
Cringle Brook WR-01-310a – F8	Main river	0.007	Moderate	Fallowfield Brook GB112069061410	Moderate/ Good by 2027	Moderate
Tributary of Cringle Brook 1 WR-01-310a – E8	Ordinary watercourse	<0.002	Moderate			
Fallowfield Brook WR-01-310a – F9	Ordinary watercourse	0.003	Moderate	Platt Brook (source to Fallowfield Brook) GB112069061060	Moderate/ Good by 2027	Moderate
Tributary of Platt Brook 1 WR-01-310a – F6	Ordinary watercourse	<0.002[9]	Low			
Gore Brook WR-01-310a – H8	Main river	0.01	Moderate			
Corn Brook WR-01-310a – I7	Ordinary watercourse	0.006	Low	Irwell/Manchester Ship Canal (Irk to confluence with Upper Mersey) GB112069061452	Moderate/ Moderate by 2015	Moderate

2.1.3 There are no licensed surface water abstractions within the study area. Records of private unlicensed surface water abstractions, that comprise those for quantities less than $20m^3$ per day, have been obtained from the local authorities. These data indicate that there are no registered private unlicensed surface water abstractions within the study area. As there is no obligation to register private water supplies, unregistered private surface water supplies may

[9] Assumed Q95 based on catchment size. Not possible to fully calculate flow value.

be present. Private water supplies will be assessed as high value receptors unless details obtained from the owner indicate otherwise.

2.1.4 There are 22 permitted discharges to surface water potentially affected by the Proposed Scheme, as shown in Table 2, one of which is within the land required for the construction of the Proposed Scheme. These have been assessed as low value receptors.

Table 2: Permitted discharges to surface water

Permit identifier (and map grid square)[2]	Distance and direction from route	Discharge type	Receiving water body
016993344 WR-01-309b – E7	850m south-east of the route of the Proposed Scheme (80m north of the land required for construction of the Proposed Scheme)	Sewage discharge - final/treated effluent (not water company)	Fairywell Brook
016991144 WR-01-309b – E5	750m north-west of the route of the Proposed Scheme (700m north-west of the land required for construction of the Proposed Scheme)	Sewage discharge - final/treated effluent (not water company)	Fairywell Brook
01M/802 WR-01-309b – E4	980m north-west of the route of the Proposed Scheme (965m north-west of the land required for construction of the Proposed Scheme)	Domestic property (single) (including farmhouse)	Fairywell Brook
0170/1315 WR-01-309b – E4	975m north-west of the route of the Proposed Scheme (1km north-west of the land required for construction of the Proposed Scheme)	Sewage discharge - final/treated effluent (not water company)	Fairywell Brook
016992561 WR-01-309b – I6	595m south-east of the route of the Proposed Scheme (225m south-east of the land required for construction of the Proposed Scheme)	Sewage discharge - final/treated effluent (not water company)	River Mersey
016982983 WR-01-309b – I3	950m north-west of the route of the Proposed Scheme (865m north-west of the land required for construction of the Proposed Scheme)	Pumping station on sewerage network (water company)	River Mersey
016942049 WR-01-309b – I3	950m north-west of the route of the Proposed Scheme (870m north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	River Mersey
01MAN0244 WR-01-310a – C3	850m north-west of the route of the Proposed Scheme (835m north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	River Mersey

Permit identifier (and map grid square)[2]	Distance and direction from route	Discharge type	Receiving water body
01MAN0236 WR-01-310a – C3	600m north-west of the route of the Proposed Scheme (665m north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	River Mersey
01MAN0237 WR-01-310a – C3	600m north-west of the route of the Proposed Scheme (665m north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	River Mersey
016982821 WR-01-310a – E5	620m north-west of the route of the Proposed Scheme (770m north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Cringle Brook
016982985 WR-01-310a – E5	530m north-west of the route of the Proposed Scheme (780m north-east of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Cringle Brook
01MAN0379 WR-01-310a – F7	365m south-east of the route of the Proposed Scheme (395m north-east of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Fallowfield Brook
016982725 WR-01-310a – G6	720m north-west of the route of the Proposed Scheme (1km north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Gore Brook
01MAN0245 WR-01-310a – G6	500m north-west of the route of the Proposed Scheme (1km north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Gore Brook
016942057 WR-01-310a – G6	300m north-west of the route of the Proposed Scheme (1km north-west of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Gore Brook
016982724 WR-01-310a – H7	360m east of the route of the Proposed Scheme (1.5km north-east of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Gore Brook
016982734 WR-01-310a – I7	800m east of the route of the Proposed Scheme (400m south-east of the land required for	Sewage discharges - storm overflow/storm tank (water company)	Corn Brook

Permit identifier (and map grid square)[2]	Distance and direction from route	Discharge type	Receiving water body
	construction of the Proposed Scheme)		
016982957 WR-01-310a – I6	360m north-east of the route of the Proposed Scheme (185m south of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Corn Brook
016993693 WR-01-310a – I6	360m north-east of the route of the Proposed Scheme (185m south of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Corn Brook
01MAN0199 WR-01-310a – I5	385m north-east of the route of the Proposed Scheme (20m north of the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	Corn Brook
01MAN0255 WR-01-310a – I4	60m north-east of the route of the Proposed Scheme (located within the land required for construction of the Proposed Scheme)	Sewage discharges - storm overflow/storm tank (water company)	River Medlock

2.2 Groundwater

2.2.1 The groundwater features crossed by the Proposed Scheme within this study area, including their location, current overall WFD status and future overall status objectives, are shown in Table 3. The information contained within Table 3 is also contained within the Environmental Statement, Volume 2, Community Area report: Davenport Green to Ardwick (MA07), Section 10 Land quality[10] and the route-wide WFD compliance assessment (Environmental Statement, Volume 5: Appendix WR-001-00000). The receptor values attributed to each individual feature are based on the methodologies set out in the SMR[3].

2.2.2 Volume 5, Water resources assessment and flood risk Map Book: map WR-02-307[2] shows the superficial and bedrock formations within MA07.

[10] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Environmental Statement, Volume 2, Community Area report: Davenport Green to Ardwick (MA07).* Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

Table 3: Summary of geology and hydrogeology in the study area

Geology	Distribution	Formation description	Aquifer classification	WFD body (ID) and current overall status[11] /2019 status	WFD objective[12]	Receptor value
Superficial deposits[13]						
Alluvium	Along the valley of the River Mersey	Clay, silt, sand and gravel	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
River terrace deposits	Some patches along the valley of the River Mersey	Sand and gravel	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Shirdley Hill Sand Formation	Isolated patches in the south-west and centre of the study area	Sand	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Glaciofluvial deposits	Some patches around Wythenshawe	Sand and gravel	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Glaciofluvial ice contact deposits	Isolated patch in the north of the study area	Sand and gravel	Secondary (Undifferentiated)	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Glaciofluvial sheet deposits	Extensive areas flanking the valley of the River Mersey	Sand and gravel	Secondary A	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Glacial till	Across much of the study area to north and south of the River Mersey valley	Sandy silty clay	Secondary (Undifferentiated)	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Bedrock						
Mercia Mudstone Group –	Underlies the route south of Wythenshawe	Mudstone and siltstone	Secondary B	Not assessed by the	Not assessed by the	Moderate

[11] Based on the 2015 RBMP. Note that where the Environment Agency has not assigned an individual water body ID to a unit, it has been assumed that it is connected to the underlying/overlying water body.

[12] Status and objectives are based on those set out in the 2015 RBMP.

[13] Superficial deposits are not necessarily listed in the order of superposition. Other superficial deposits may be present between the deposits shown in the table and bedrock, including deposits that do not appear in the table.

Geology	Distribution	Formation description	Aquifer classification	WFD body (ID) and current overall status[11] /2019 status	WFD objective[12]	Receptor value
Sidmouth Mudstone Formation – Bollin Mudstone Member		with some halite bearing units, and presence of gypsum		Environment Agency	Environment Agency	
Mercia Mudstone Group – Tarporley Siltstone Formation	Underlies the route between Wythenshawe and Northenden	Siltstone, mudstone and sandstone	Secondary B	Not assessed by the Environment Agency	Not assessed by the Environment Agency	Moderate
Sherwood Sandstone Group – Helsby Sandstone Formation	A small wedge-shaped area between Northenden and the M60	Pebbly sandstone	Principal	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	High
Sherwood Sandstone Group – Wilmslow Sandstone Formation	Present in a band between the M60 and Withington	Sandstone	Principal	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	High
Sherwood Sandstone Group – Chester Formation	Present between Withington, Didsbury and Rusholme and Fallowfield	Sandstone	Principal	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	High
Cumbrian Coast Group – Manchester Marls Formation	Present in north-west to south-east trending bands in the Rusholme and West Gorton areas	Mudstone	Secondary B	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100)	Good by 2021	Moderate

Geology	Distribution	Formation description	Aquifer classification	WFD body (ID) and current overall status[11] /2019 status	WFD objective[12]	Receptor value
				Poor/Poor		
Appleby Group – Collyhurst Sandstone Formation	Present in north-west to south-east trending bands in the Rusholme and West Gorton areas	Sandstone	Principal	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	High
Warwickshire Group – Halesowen Formation	Present in a north-west to south-east trending band in the Rusholme and West Gorton areas	Mudstone, sandstone and siltstone	Secondary A	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	Moderate
Warwickshire Group – Halesowen Formation – Holt Town Sandstone Bed	Present in a north-west to south-east trending band in the Bradford area	Sandstone	Secondary A	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	Moderate
Warwickshire Group – Halesowen Formation – Great Mine Limestone	Present in a north-west to south-east trending band in the Rusholme and West Gorton areas	Limestone	Secondary A	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	Moderate
Warwickshire Group – Etruria Formation	Present in a north-west to south-east trending band in the Rusholme area	Sandstone and mudstone	Secondary A	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	Moderate

Geology	Distribution	Formation description	Aquifer classification	WFD body (ID) and current overall status[11] /2019 status	WFD objective[12]	Receptor value
Pennine Coal Measures Group - Pennine Upper Coal Measures Formation	Present in a north-west to south-east trending band in the Beswick area	Mudstone, sandstone and siltstone	Secondary A	Manchester and East Cheshire Permo-Triassic Sandstone Aquifer (GB41201G101100) Poor/Poor	Good by 2021	Moderate

2.2.3 The alluvium, river terrace deposits, Shirdley Hill Sand Formation, glaciofluvial deposits, and glaciofluvial sheet deposits in the study area are classified as Secondary A aquifers by the Environment Agency. The glacial till and the glaciofluvial ice contact deposits are designated as Secondary (Undifferentiated) aquifers by the Environment Agency.

2.2.4 There are aquifers in the six geological bedrock Groups in the study area. The Mercia Mudstone Group, comprising Bollin Mudstone Member and Tarporley Siltstone Formation, is classified as a Secondary B aquifer. The Helsby Sandstone Formation, the Wilmslow Sandstone Formation and the Chester Formation, within the Sherwood Sandstone Group, are classified as Principal aquifers. The Manchester Marls Formation of the Cumbrian Coast Group is classified as a Secondary B aquifer. The Collyhurst Sandstone Formation of the Appleby Group is classified as a Principal aquifer. The Halesowen Formation, Holt Town Sandstone Bed, Great Mine Limestone and Etruria Formation of the Warwickshire Group are all classified as Secondary A aquifers. The Pennine Upper Coal Measures Formation of the Pennine Coal Measures Group is classified as a Secondary A aquifer.

2.2.5 The structural geology of the study area is complex, with a series of north-west to south-east trending major faults traversing the study area, some of which have vertical displacements of over 200m in places.

2.2.6 There are two Environment Agency observation boreholes that monitor groundwater levels in the study area. These are Wythenshawe Park Shallow borehole and Wythenshawe Park Deep borehole, both at the same location, 990m north-west of the route of the Proposed Scheme. The location of these monitoring boreholes is shown in Figure 1.

2.2.7 Figure 2 presents the time-series of available groundwater level monitoring data from these locations. Information available on the British Geological Society (BGS) website indicates that:

- the Wythenshawe Park Shallow borehole is 5m deep and monitors groundwater levels in the glaciofluvial sheet deposits; and
- the Wythenshawe Park Deep borehole is 111m deep and monitors groundwater levels in the Sherwood Sandstone Group.

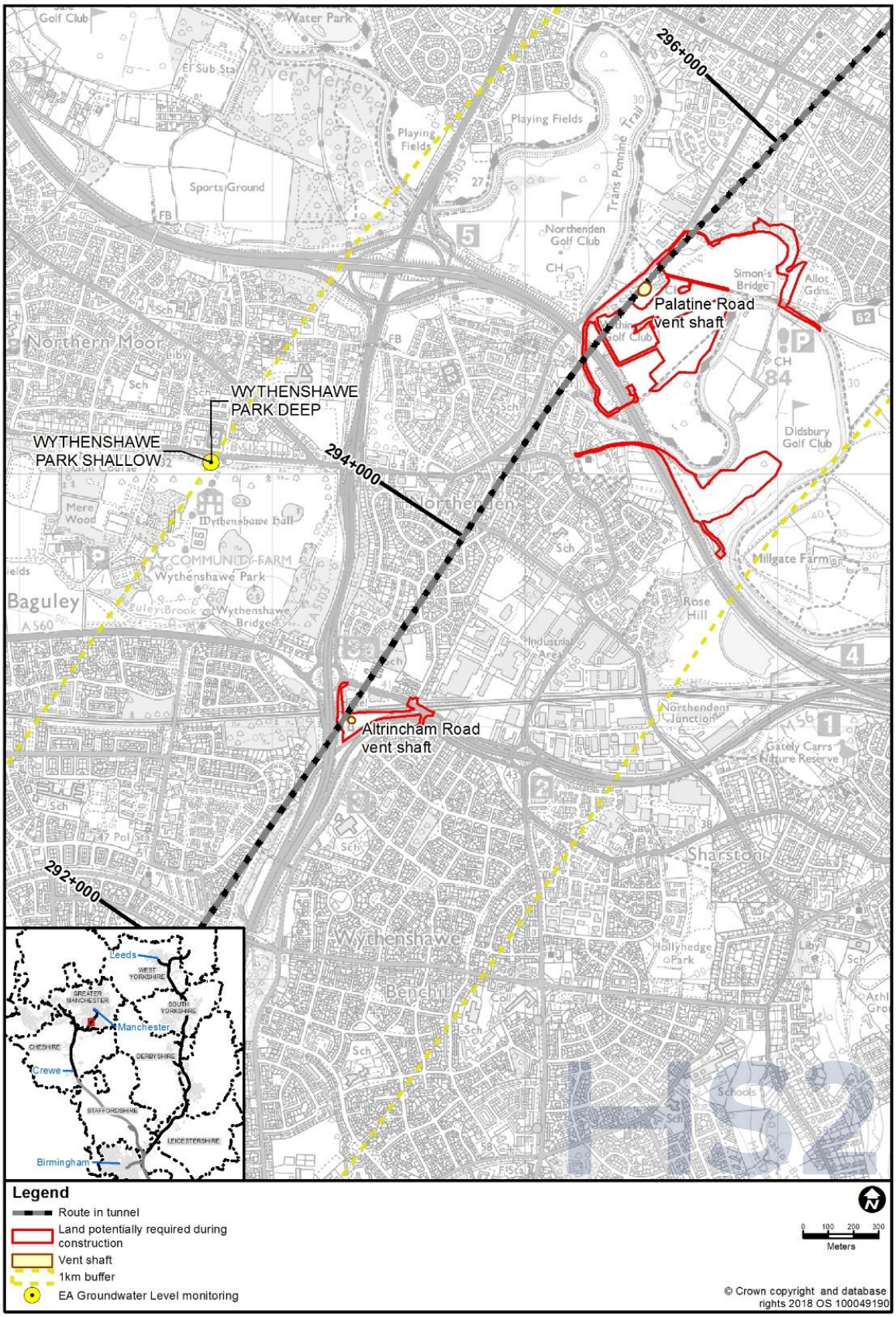
2.2.8 The Mercia Mudstone Group (Tarporley Siltstone Formation) Secondary B aquifer is present below the superficial deposits at this location. However, geological data available for the route of the Proposed Scheme indicates that the Sherwood Sandstone Group (Helsby Sandstone Formation) Principal aquifer is present below the Tarporley Siltstone Formation, at a depth of approximately 45m, in the area of the observation boreholes.

2.2.9 Figure 2 shows that groundwater levels are similar and at a shallow depth in both boreholes. Depths to groundwater were less than 2.5m below borehole datum for all measurements.

2.2.10 Water levels in the shallow boreholes are lower than those in the deep borehole throughout the monitoring period, suggesting that water levels in the deep sandstone aquifer may be supporting water levels in the shallow glaciofluvial sheet deposits aquifer.

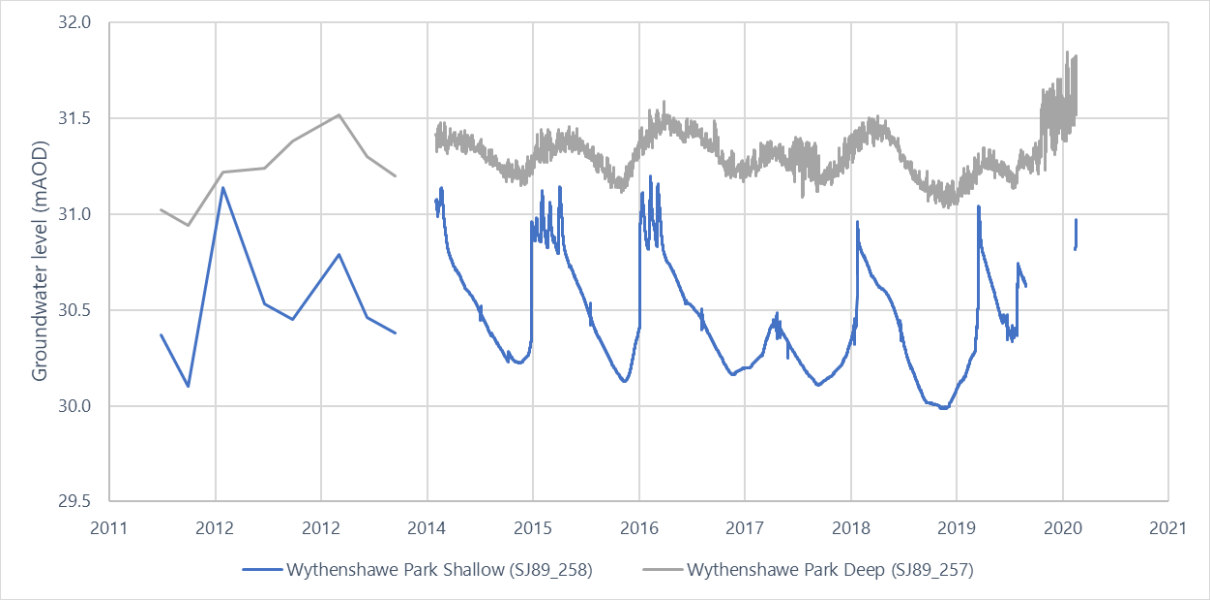
2.2.11 There is clear annual seasonal variation in groundwater level in both boreholes, although the winter recharge is supressed in 2017, which was a dry winter. The seasonal fluctuation is more pronounced in the shallow borehole with an annual range of approximately 1m compared to 0.5m in the deep borehole. Groundwater levels over the time period have been relatively stable.

Figure 1: Location of Environment Agency groundwater level monitoring boreholes



Data provided by the Environment Agency

Figure 2: Time series of available Environment Agency groundwater level monitoring data



Data provided by the Environment Agency

2.2.12 No groundwater monitoring data are available for the other Principal aquifers or Secondary A and Secondary B aquifers in the study area. Water strikes recorded on borehole logs available via BGS have, therefore, been referred to for the purpose of the assessment.

2.2.13 Groundwater in the superficial aquifers in the study area is, in general, expected to be shallow within the river valleys and at greater depth below the valley sides and interfluves. The direction of groundwater flow is likely to follow the general topography, with surface watercourses acting as discharge locations for convergent groundwater flow. Where groundwater levels are not known, they have been assumed to be at or close to ground level for the purpose of a precautionary assessment.

2.2.14 In the superficial deposits, Secondary A and Secondary (Undifferentiated) aquifers, most groundwater flow is expected to be through the intergranular matrix in these unconsolidated deposits.

2.2.15 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 lenses called 'skerries'. There may also be a minor element of localised fracture flow.

2.2.16 Groundwater in the Sherwood Sandstone Group is based on hydrogeology maps available from the BGS[14]. The hydrogeology maps suggest groundwater flow in the Sherwood Sandstone is controlled by the River Mersey, flowing generally north to south to the north of the River Mersey and south to north to the south of the River Mersey. Due to limited

[14] British Geological Survey (1989), *Hydrogeological map of Clwyd and the Cheshire Basin including parts of the hydrometric areas 54, 65, 66, 67, 68, 69 and 70.* Available online at: https://webapps.bgs.ac.uk/data/maps/maps.cfc?method=viewRecord&mapId=11567.

groundwater level data, it is not possible to confirm the current direction of groundwater flow. Groundwater flow is likely to be strongly influenced by anisotropy within the aquifer, that typically exhibits greater horizontal than vertical permeability. Intergranular flow within the sandstone matrix is expected to play a significant role in groundwater flow as well as fracture flow. Horizontal (matrix) flow and fracture flow are also expected to play a significant role in groundwater flow in aquifers in the Cumbrian Coast Group, the Appleby Group, the Warwickshire Group and the Pennine Coal Measures Group.

2.2.17 Up-coning of deep saline groundwater in the Sherwood Sandstone Group aquifer has occurred in the Trafford Park area, as reported by BGS[15]. Trafford Park is located approximately 6.5km north-west of the Proposed Scheme. The up-coning has occurred as a result of high rates of groundwater abstraction from deep boreholes in the area over many years. BGS presents water quality data for the period 1986 to 2002 for two boreholes with depths of 165m and 183m in Trafford Park that illustrates the presence at depth of groundwater with high sodium and chloride concentrations[15].

2.2.18 BGS also indicates that reasonably good quality groundwater may be obtained at Trafford Park from shallower depths (below approximately 40m), provided boreholes do not intercept the saline up-coning. However, it is not known how extensive the presence of deep saline groundwater may be across the Sherwood Sandstone Group aquifer in the wider Manchester area.

2.2.19 Water quality data for two abstraction boreholes was available for most years in the period 2000 to 2005, with a total of five or six sets of analyses for each site. The first site, Borehole at Didsbury golf club, Northenden, Wythenshawe (borehole licence number 2569015006) is located within the study area, while the other, Chorlton-cum-Hardy golf club is located 1.8km to the west of the Proposed Scheme. The depths of the boreholes are 37m at Didsbury golf club (in the Wilmslow Sandstone Formation) and 50m at Chorlton-cum-Hardy golf club (constructed in the Helsby Sandstone Formation). Both boreholes were constructed in the unconfined Sherwood Sandstone Group Principal aquifer. At both sites, the overall salinity was at a level that would normally be expected for groundwater from the unconfined Sherwood Sandstone aquifer. Electrical conductivity was in the range 910 to 1,030 micro-Siemens per centimetre (µS/cm) at Chorlton-cum-Hardy golf club and 410 to 650µS/cm at Didsbury golf club. For comparison, the electrical conductivity limit of drinking water is 2,500 µS/cm and the values of electrical conductivity in the Trafford Park area have been found to exceed 10,000µS/cm[15, 16].

2.2.20 Table 4 summarises groundwater abstractions and their locations are shown on Volume 5, Water resources assessment and flood risk Map Book: map WR-02-307[2].

[15] British Geological Society (2003), *Baseline Report Series, 8. The Permo-Triassic Sandstones of Manchester and East Cheshire*. Available online at: http://nora.nerc.ac.uk/id/eprint/3573/.

[16] *Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption*. Brussels, European Parliament and European Council.

2.2.21 There are no source protection zones (SPZ) associated with licensed public water supplies in the study area. The route of the Proposed Scheme is located on the boundary of a source protection zone 3 (SPZ3) towards the northern end of this study area, near Rusholme. The SPZ3 is associated with an abstraction located approximately 3km north-west of the route of the Proposed Scheme. The boundary of the SPZ3 has been modelled to coincide with a fault aligned approximately north-south which was assumed to form a barrier to groundwater flow.

2.2.22 There is one licensed private abstraction from groundwater in the study area. It does not have mapped SPZ as it is used for spray irrigation. The abstraction has been assessed as a moderate value receptor.

2.2.23 The private water supply information has been provided by the local authorities. Information regarding deregulated abstractions has been provided by the Environment Agency. Where land access has been available, surveys have been undertaken to confirm unlicensed abstraction details. Where the exact details of an unlicensed abstraction are not known, a precautionary assessment has been undertaken.

2.2.24 There is the potential for further unlicensed abstractions to exist, as a licence is not required for abstraction volumes below 20m^3 per day and not all unlicensed abstractions are registered with the local authority. These may also need to be protected.

Table 4: Summary of groundwater abstractions

Name, licence number (and map grid square)[17]	Distance and direction from route	Abstraction source	Maximum annual abstraction quantity (m^3)	Maximum daily abstraction quantity (m^3)	Purpose	Number of boreholes
Private licensed water supplies						
Borehole at Didsbury Golf Club, Northenden, Wythenshawe 2569015006 WR-02-307 – D6	550m south-east of the route of the Proposed Scheme (200m south of land required for the construction of the Proposed Scheme)	Sherwood Sandstone Group – Wilmslow Sandstone Formation	9,092	68.2	Golf course - Spray irrigation	1

2.2.25 There are no permitted discharges to groundwater in the study area.

2.3 Groundwater – surface water interactions

2.3.1 Table 5 summarises the potential groundwater – surface water interactions identified within the study area.

[17] Map grid squares on Volume 5, Water resources assessment and flood risk Map Book: map WR-02-307 for SPZ, 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.

2.3.2 Along with the main surface watercourses, that could have connection with groundwater, potential springs and sinks have been identified within the study area from Ordnance Survey (OS) maps and detailed river network data provided by the Environment Agency. Where land access has been available, these have been surveyed to check if they are true expressions of groundwater (and therefore could contribute to flows to surface water bodies), or if they are simply land drainage features. Where surveys have proved the latter, the features are recorded as such in Table 5, but are excluded from the groundwater – surface water interactions impact assessment in Volume 5: Water resources assessment, Appendix WR-003-MA07 and they are not shown in the table below or on Volume 5, Water resources assessment and flood risk Map Book: map WR-02-307[2], because they are implicitly already included in the assessment of surface waters. Where they are inflows to minor ditches, for example, then any related impacts will be identified as part of the assessment on surface water features. In the absence of site surveys, the potential spring features have been assumed to comprise springs and to be high value receptors. Where a spring does not support water dependant habitat then the corresponding value of the receiving surface watercourse is applied.

Table 5: Groundwater – surface water interactions

Feature (and map grid square)[18]	Distance and direction from route	Formation	Elevation (mAOD)	Comments
Watercourses				
Fairywell Brook WR-02-307 – A5	Crossed by the route of the Proposed Scheme	Glacial till over the Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member)	60	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Mill Brook WR-02-307 – B5	Crossed by the route of the Proposed Scheme	Glaciofluvial deposits and glacial till over the Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member)	60	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Baguley Brook WR-02-307 – C5	Crossed by the route of the Proposed Scheme	Glaciofluvial deposits and glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation and Sidmouth Mudstone Formation – Bollin Mudstone Member)	38	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Tributary of Baguley Brook WR-02-307 – C5	Crossed by the route of the Proposed Scheme	Glaciofluvial deposits and glacial till over the Mercia Mudstone Group	38	Watercourses are likely to be in hydraulic connection with the underlying and

[18] Volume 5, Water resources assessment and flood risk Map Book: map WR-02-307. 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)[18]	Distance and direction from route	Formation	Elevation (mAOD)	Comments
		(Tarporley Siltstone Formation)		adjacent permeable superficial deposits.
River Mersey WR-02-307 – D5	Crossed by the route of the Proposed Scheme	Alluvium, river terrace deposits and glacial till over the Sherwood Sandstone Group (Wilmslow Sandstone Formation and Helsby Sandstone Formation) and the Mercia Mudstone Group (Tarporley Siltstone Formation)	25	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Tributary of the River Mersey 1 WR-02-307 – D6	600m east of the route of the Proposed Scheme (150m north of land required for the construction of the Proposed Scheme)*	Alluvium over the Sherwood Sandstone Group (Wilmslow Sandstone Formation)	26	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Tributary of the River Mersey 3 WR-02-307 – D5	240m west of the route of the Proposed Scheme (390m south-west of land required for the construction of the Proposed Scheme)*	Alluvium and river terrace deposits over the Sherwood Sandstone Group (Helsby Sandstone Formation) and the Mercia Mudstone Group (Tarporley Siltstone Formation)	26	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Tributary of the River Mersey 2 WR-02-307 – D5	Crossed by the route of the Proposed Scheme	Alluvium and river terrace deposits over the Sherwood Sandstone Group (Wilmslow Sandstone Formation)	25	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Cringle Brook WR-02-307 – E6 and F6	Crossed by the route of the Proposed Scheme	Glacial till over the Sherwood Sandstone Group (Wilmslow Sandstone Formation and Chester Formation), the Cumbrian Coast Group (Manchester Marls Formation), the Appleby Group (Collyhurst Sandstone Formation) and the Warwickshire Group (Halesowen Formation and Etruria Formation)	39	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Tributary of Cringle Brook 1 WR-02-307 – F6	250m south-east of the route of the Proposed Scheme (420m south of land required for the	Glacial till over the Sherwood Sandstone Group (Chester Formation), the Cumbrian Coast Group (Manchester Marls Formation) and the	41	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.

Feature (and map grid square)[18]	Distance and direction from route	Formation	Elevation (mAOD)	Comments
	construction of the Proposed Scheme)*	Appleby Group (Collyhurst Sandstone Formation)		
Fallowfield Brook WR-02-307 – F6	Crossed by the route of the Proposed Scheme	Glacial till over the Sherwood Sandstone Group (Wilmslow Sandstone Formation and Chester Formation), the Cumbrian Coast Group (Manchester Marls Formation), the Appleby Group (Collyhurst Sandstone Formation) and the Warwickshire Group (Halesowen Formation and Etruria Formation)	45	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Tributary of Platt Brook 1 WR-02-307 – F6	Crossed by the route of the Proposed Scheme	Glacial till over the Sherwood Sandstone Group (Chester Formation), the Cumbrian Coast Group (Manchester Marls Formation), the Appleby Group (Collyhurst Sandstone Formation) and the Warwickshire Group (Halesowen Formation and Etruria Formation)	51	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Gore Brook WR-02-307 – G6	Crossed by the route of the Proposed Scheme	Glacial till over the Sherwood Sandstone Group (Chester Formation), the Cumbrian Coast Group (Manchester Marls Formation) and the Appleby Group (Collyhurst Sandstone Formation)	53	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.
Corn Brook WR-02-307 – G5	Crossed by the route of the Proposed Scheme	Glacial till over the Sherwood Sandstone Group (Chester Formation), the Cumbrian Coast Group (Manchester Marls Formation), the Appleby Group (Collyhurst Sandstone Formation), the Warwickshire Group (Halesowen Formation, Great Mine Limestone and Etruria Formation) and the Pennine Upper Coal Measures Formation	47	Watercourses are likely to be in hydraulic connection with the underlying and adjacent permeable superficial deposits.

Feature (and map grid square)[18]	Distance and direction from route	Formation	Elevation (mAOD)	Comments
Springs or potential spring features				
Potential spring at Dobbinetts Lane, Roundthorn WR-02-307 – B4	950m north-west of the route of the Proposed Scheme (990m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member)	44	Surveys have shown this to be a culvert that discharges to an unnamed tributary and it is therefore included in the surface water assessment.
Potential spring at Blackcarr Wood south, Baguley WR-02-307 – C5	330m north-west of the route of the Proposed Scheme (370m south-west of land required for the construction of the Proposed Scheme)*	Outcrop Mercia Mudstone Group (Tarporley Siltstone Member) close to glacial till boundary	40	Surveys unable to confirm the nature of this feature. Assumed to be a high value receptor until verified by further surveys. If present, it is likely to discharge from the glacial till.
Potential sink at Blackcarr Wood north, Baguley WR-02-307 – C5	400m north-west of the route of the Proposed Scheme (360m west of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	38	Surveys have shown this to be a culvert that discharges to an unnamed tributary and it is therefore included in the surface water assessment.
Potential spring at Round Wood south, Northenden WR-02-307 – C5	10m east of the route of the Proposed Scheme (180m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	39	Surveys have shown this to be a culvert that discharges to Round Wood Drain and it is therefore included in the surface water assessment.
Potential sink at Round Wood north, Northenden WR-02-307 – C5	Crossed by the route of the Proposed Scheme*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	35	Surveys have shown this to be a culvert that collects water from Round Wood Drain and it is therefore included in the surface water assessment.
Potential spring at Gib Lane Wood south, Baguley WR-02-307 – C5	330m north-west of the route of the Proposed Scheme (320m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	38	Surveys have shown this to be a land drain that discharges to Gib Lane Wood drains and it is therefore included in the surface water assessment.
Potential spring at Gib Lane Wood east, Baguley WR-02-307 – C5	130m north-west of the route of the Proposed Scheme (380m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	37	Not surveyed. Assumed to be a high value receptor until verified by surveys. If present, it is likely to

Feature (and map grid square)[18]	Distance and direction from route	Formation	Elevation (mAOD)	Comments
				discharge from the glacial till.
Potential sink at Gib Lane Wood south, Baguley WR-02-307 – C5	370m north-west of the route of the Proposed Scheme (435m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	37	Not surveyed. Shown on OS map to be a sink, that is assumed will discharge to the glacial till. Assumed to be a high value receptor until verified by surveys.
Potential spring at Gib Lane, Baguley WR-02-307 – C5	390m north-west of the route of the Proposed Scheme (448m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	35	Surveys have shown this to be a land drain that discharges to Gib Lane Wood drains and it is therefore included in the surface water assessment.
Potential sink at Gib Lane Wood west, Baguley WR-02-307 – C5	450m north-west of the route of the Proposed Scheme (580m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	33	Surveys have shown this to be a land drain that discharges to Gib Lane Wood drains and it is therefore included in the surface water assessment.
Potential sink at Gib Lane Wood north, Baguley WR-02-307 – C5	440m north-west of the route of the Proposed Scheme (620m north of land required for the construction of the Proposed Scheme)*	Glacial till over the Mercia Mudstone Group (Tarporley Siltstone Formation)	33	Surveys have shown this to be a land drain that discharges to Gib Lane Wood drains and it is therefore included in the surface water assessment.
Potential sink at Stenner Lane Museum & Art Gallery WR-02-307 – D6	990m south-east of the route of the Proposed Scheme (400m south-east of land required for the construction of the Proposed Scheme)	Alluvium over the Sherwood Sandstone Group (Wilmslow Sandstone Formation)	27	Not surveyed. Shown on OS map to be a sink, that is assumed will discharge to the alluvium. Assumed to be a high value receptor until verified by surveys.

** route in tunnel therefore land required for construction only at shaft sites.*

2.4 Water dependent habitats

2.4.1 Table 6 summarises the groundwater dependent habitats within the study area. There are no surface water dependent habitats in the study area.

Table 6: Water dependent habitats

Name (and map grid square)[19]	Distance and direction from route	Designation	Comments
Groundwater dependent habitats			
Blackcarr Wood and Baguley Bottoms EC-01-523 – B6 and C6	Crossed by the route of the Proposed Scheme	Site of Biological Importance (SBI)	Springs and a pond connected to Baguley Brook are located within the site. These waterbodies may be at least partially supported by groundwater flow from glaciofluvial deposits and glacial till underlying the site. The site has been included as a groundwater dependent habitat on a precautionary basis.
Wythenshawe Park (Gib Lane Wood) EC-01-523 – D4	260m north-west of the route of the Proposed Scheme (300m north of land required for the construction of the Proposed Scheme)	Local Nature Reserve (LNR) (and SBI)	Surveys have confirmed this habitat is groundwater dependent. Indicators include ponds in some areas within the habitat and drainage in areas of lower topography associated with wetland habitats. Groundwater flow could occur through underlying glaciofluvial deposits and glacial till, with some contribution from rainfall.
Round Wood EC-01-523 – D5 and E5	Crossed by the route of the Proposed Scheme	SBI and ancient woodland	There may be groundwater flow supporting the habitat from the glaciofluvial deposits and glacial till underlying the site. The site has been included as a groundwater dependent habitat on a precautionary basis.
Rose Hill Woods EC-01-523 – F8	810m south-west of the route of the Proposed Scheme (260m south of land required for the construction of the Proposed Scheme)	SBI	A series of drains in the habitat flow from Didsbury Golf Course, and there is a large pond to the east of the habitat. The dependency of these waterbodies on groundwater is currently unknown, but they may be at least partially supported by groundwater from alluvium and glacial till underlying the site. The site has been included as a groundwater dependent habitat on a precautionary basis.
Stenner Woods and Milgate Fields, (Fletchers Moss) EC-01-523 – H8	970m south-west of the route of the Proposed Scheme (50m south-west of land required for the construction of the Proposed Scheme)	LNR (SBI)	The habitat is a wetland dominated by crack willow trees. Much of the ground is submerged throughout the year. The site has been included as a groundwater dependent habitat on a precautionary basis.
Wrengate Wood EC-01-524 – B5	Crossed by the route of the Proposed Scheme	SBI and ancient woodland	There is a pond located to the west side of the habitat. There may be groundwater flow supporting the habitat

[19] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Environmental Statement, Volume 5 Ecology Map Book, Map Series EC-01.* Available online at: https://www.gov.uk/government/collections/hs2-phase-2b-crewe-manchester-environmental-statement.

Name (and map grid square)[19]	Distance and direction from route	Designation	Comments
			from the alluvium, river terrace deposits and glaciofluvial deposits underlying the site. The site has been included as a groundwater dependent habitat on a precautionary basis.

3 References

British Geological Survey (1989), *Hydrogeological map of Clwyd and the Cheshire Basin including parts of the hydrometric areas 54, 65, 66, 67, 68, 69 and 70.* Available online at: https://webapps.bgs.ac.uk/data/maps/maps.cfc?method=viewRecord&mapId=11567.

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