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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix WR-003-0MA07

Water resources and flood risk

MA07: Davenport Green to Ardwick

Water resources assessment

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Water resources assessment

M312

Department for Transport

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1 Introduction

1.1 Structure

1.1.1 This report is an appendix to the water resources and flood risk assessment. It presents the water resources assessment for the Proposed Scheme in relation to the Davenport Green to Ardwick area (MA07).

1.1.2 This appendix should be read in conjunction with:

- Volume 2, Community Area reports;
- Volume 3, Route-wide effects;
- Volume 4, Off-route effects; and
- Volume 5, Appendices.

1.1.3 The water resources and flood risk assessments include both route-wide and community area specific appendices. The route-wide appendices comprise:

- a Water Framework Directive (WFD) compliance assessment (Volume 5: Appendix WR-001-00000); and
- a draft water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-007-00000).

1.1.4 For MA07, the flood risk assessment (Volume 5: Appendix WR-005-0MA07) should also be referred to.

1.1.5 Additional information relevant to this assessment is set out in Background Information and Data (BID):

- Water resources assessment baseline data (BID WR-004-0MA07)[1]; and
- Water Framework Directive compliance assessment baseline data that is reported for the Proposed Scheme (BID WR-002-00001)[2].

1.2 Scope, assumptions and limitations

1.2.1 The scope, assumptions and limitations for the water resources assessment are set out in the Environmental Impact Assessment Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-00001).

1.2.2 The MA07 area covers a 13.5km long section of the Proposed Scheme. The spatial scope of the assessment is based initially on the identification of surface water and groundwater features within 500m of the route of the Proposed Scheme (due to its urban location). For the purposes of this assessment this spatial scope is defined as the study 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).

1.2.3 The assessment considers the construction and operational features of the Proposed Scheme within this study area. These are shown on Volume 2, MA07 Map Book, Map Series CT-05 and CT-06.

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water resources assessment baseline data,* BID WR-004-0MA05. Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

[2] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water Framework Directive compliance assessment baseline data,* BID WR-002-00001. Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

1.2.4 This assessment covers the potential impacts of the Proposed Scheme on existing surface water and groundwater resources, including consideration of:

- surface waters[3];
- aquifers;
- abstractions (licensed and unlicensed) and consented discharges;
- springs and other groundwater – surface water interactions with implications for water resources; and
- water dependent habitats.

1.2.5 The route-wide WFD compliance assessment (Volume 5: Appendix WR-001-00000) provides a comprehensive review of the potential impacts of the Proposed Scheme on designated WFD surface water and groundwater bodies. The WFD compliance assessment, that 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 spillage and routine discharges of runoff from all roads within the study area that are affected by the Proposed Scheme during the construction and operational phases.

1.2.7 The risk to water resources associated with accidents or spillages from trains during the operation of the Proposed Scheme are considered on a route-wide basis within Volume 3, Route-wide effects, Section 16, Water resources and flood risk.

1.2.8 Mineral resources (operational or historical) and potential impacts to groundwater quality from existing land contamination are presented in the Land quality report, Volume 5: Appendix LQ-001-0MA07.

1.3 Study area description and key features

1.3.1 The study area is predominantly urban, passing largely through Sale, Gatley, and suburbs of Manchester.

1.3.2 Within the Davenport Green to Ardwick area, the Proposed Scheme will be constructed largely as twin bored tunnel. The southern and northern ends of the Proposed Scheme in MA07 will be constructed as tunnel portal and cuttings. There are four shafts within the Davenport Green to Ardwick area. There are no embankments, viaducts or ground level sections.

1.3.3 The main environmental features of relevance to water resources include:

- the River Mersey, Gore Brook, Baguley Brook, Cringle Brook, Fallowfield Brook, Corn Brook and their associated tributaries;
- the Sherwood Sandstone Group, and Appleby Group which are Principal aquifers;
- the Warwickshire Group which is a Secondary A aquifer;
- the Mercia Mudstone Group and Cumbrian Coast Group which are Secondary B aquifers;
- the permeable superficial deposits Secondary A and Secondary (Undifferentiated) aquifer;
- four licensed private groundwater abstractions; and
- Blackcarr Wood and Baguley Bottoms Site of Biological Interest (SBI), Wythenshawe Park Local Nature Reserve (LNR) and Gib Lane Wood SBI, Round Wood SBI and ancient woodland, Rose Hill Woods SBI, Stenner Woods and Millgate Fields LNR, Fletchers Moss SBI, and Wrengate Wood SBI and ancient woodland.

[3] Ponds are not included in the water resources assessment; these are assessed as ecological receptors in Volume 2.

1.4 Stakeholder engagement

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

- the Environment Agency, particularly with regard to the temporary dewatering of tunnel ventilation and intervention shaft (vent shaft), and the interaction of the Palatine Road vent shaft with the Didsbury flood storage basin;
- Greater Manchester Combined Authority (GMCA), Trafford Metropolitan Borough Council (TMBC) and Manchester City Council (MCC), with regard to private unlicensed water abstractions;
- United Utilities Group PLC 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).

2 Site specific surface water assessments

2.1 Summary of assessment

2.1.1 Table 1 presents the potential impacts and effects related to surface water resources and features potentially affected by the Proposed Scheme. Further baseline details for these receptors are provided in the Water resources assessment baseline data (BID WR-004-0MA07). Maps showing the location of the watercourses presented below can be found in the WFD compliance assessment baseline data for the Proposed Scheme (BID WR-002-00001). Those surface water features potentially affected by groundwater interactions are described in Section 3.1.

2.1.2 The WFD compliance assessment (Volume 5: Appendix WR-001-00000) provides a comprehensive review of the aspects of the Proposed Scheme that have potential to cause permanent impacts on water bodies, or that could constrain the future achievement of water body objectives. Temporary construction impacts, defined as those that 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 1.

2.1.3 Construction compounds may have substantial water demands where they are associated with design elements, such as such as batching plant and tunnelling by Tunnel Boring Machine (TBM). At these locations the construction compounds may require water abstractions to augment other supply options. Where these are required, then an assessment will include location-specific engagement with the Environment Agency and other water undertakers on the availability of water at that location.

2.1.4 The draft Code of Construction Practice (CoCP) sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme to protect surface waters (see Volume 5: Appendix CT-002-00000).

Table 1: 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
Surface water bodies									
Fairywell Brook	Low	• Manchester tunnel • Manchester tunnel south portal • Manchester Airport High Speed Station cutting retaining wall • Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	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)
		• Drainage outfall from attenuation tank	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Baguley Brook	Moderate	• Manchester tunnel • Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include 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)

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
Mill Brook	Moderate	• Manchester tunnel	Proposed Scheme is in tunnel beneath the watercourse (top of tunnel approximately 25m below ground level) so limited potential for surface water flow and quality impacts.	Magnitude of impact – Negligible 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)
Tributary of Baguley Brook	Low	• Manchester tunnel	Tributary of Bagley Brook is in culvert where is crossed by the proposed scheme. The route is also in tunnel in this location so there is limited potential for surface flow and quality impacts from the tunnel.	Magnitude of impact – Negligible 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)
		• Altrincham Road vent shaft • Watercourse crossing by proposed access road • Utility diversion • Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	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)
		• Watercourse crossing by proposed access road • Drainage outfall from attenuation tank	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Round Wood Drain	Low	• Manchester tunnel	Proposed Scheme is in tunnel beneath the watercourse (top of tunnel approximately 45m below ground level) so limited potential for surface water flow and quality impacts.	Magnitude of impact – Negligible 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)
River Mersey	Very high	• Manchester tunnel • Palatine Road vent shaft • Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include 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)
Tributary of River Mersey 1	Moderate	None	No works directly adjacent to the watercourse so limited potential for surface water flow and quality effects.	Magnitude of impact – Negligible	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	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
				Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
M60 Drainage	Moderate	• Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include 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)
Tributary of River Mersey 3	Moderate	None	No works directly adjacent to the watercourse so limited potential for surface water flow and quality effects.	Magnitude of impact – Negligible 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)
Tributary of River Mersey 2	Moderate	• Manchester tunnel • Palatine Road vent shaft • Demolition of commercial properties • Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	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)
		• Drainage outfall from track drainage	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Mitigation measures will include appropriate drainage design, and measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Red Lion Brook	Low	• Manchester tunnel	Proposed Scheme is in tunnel beneath the watercourse (top of tunnel approximately 35m below ground level) so limited potential for surface water flow and quality impacts.	Magnitude of impact – Negligible 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)
Shaw Brook	Low	• Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include 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)
Cringle Brook	Moderate	• Manchester tunnel	Proposed Scheme is in tunnel beneath the watercourse (top of tunnel 36m below ground	Magnitude of impact – Negligible	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	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
			level) so limited potential for surface water flow and quality impacts.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Tributary of Cringle Brook 1	Moderate	None	No works directly adjacent to the watercourse so limited potential for surface water flow and quality effects.	Magnitude of impact – Negligible 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)
Fallowfield Brook	Moderate	• Manchester tunnel	Proposed Scheme is in tunnel beneath this culverted watercourse (top of tunnel 36m below ground level) so limited potential for surface water flow and quality impacts.	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)
Tributary of Platt Brook 1	Low	• Manchester tunnel	Proposed Scheme is in tunnel beneath this culverted watercourse (top of tunnel 36m below ground level) so limited potential for surface water flow and quality impacts.	Magnitude of impact – Negligible 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)
Gore Brook	Moderate	• Manchester tunnel	Proposed Scheme is in tunnel beneath this culverted watercourse (top of tunnel 34m below ground level) so limited potential for surface water flow and quality impacts.	Magnitude of impact – Negligible 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)
Corn Brook	Low	• Manchester tunnel	Proposed Scheme is in tunnel beneath this culverted watercourse (top of tunnel approximately 16m below ground level) so limited potential for surface water flow and quality impacts.	Magnitude of impact – Negligible 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)
Discharges to surface water									
Discharge 016993344	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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)
Discharge 016991144 Discharge 01M/802	Low	None	Located downstream of the Proposed Scheme and discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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 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
Discharge 0170/1315									
Discharge 016992561	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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)
Discharge 016982983	Low	None	Located downstream of the Proposed Scheme and discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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)
Discharge 016942049 Discharge 01MAN0244 Discharge 01MAN0236 Discharge 01MAN0237 Discharge 016982821 Discharge 016982985	Low	None	Located downstream of the Proposed Scheme and discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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)
Discharge 01MAN0379	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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)
Discharge 016982725 Discharge 01MAN0245 Discharge 016942057	Low	None	Located downstream of the Proposed Scheme and discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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 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
Discharge 016982724 Discharge 016982734 Discharge 016982957 Discharge 016993693 Discharge 01MAN0199	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment. Therefore, the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible 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)
Discharge 01MAN0255	Low	• Ardwick North cutting retaining wall • Temporary works such as compounds, stockpiles and access routes	Located within the land required for construction of the Proposed Scheme. This discharge has potential to be physically impacted by construction work.	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)

3 Site specific groundwater assessments

3.1 Summary of assessment

3.1.1 Table 2 presents all groundwater receptors within the study area and summarises potential impacts from the design elements of the Proposed Scheme that are relevant to the water environment. Further baseline details for these receptors are provided in the Water resources assessment baseline data (BID WR-004-0MA07). Individual impact assessments for each design element are presented in Sections 3.2 to 3.7.

3.1.2 Construction compounds may have substantial water demands where they are associated with design elements, such as batching plant and tunnelling by TBM. At these locations the construction compounds may require water abstractions to augment other supply options. Where these are required, then an assessment will include location-specific engagement with the Environment Agency, water companies and other water undertakers on the availability of water at that location.

3.1.3 The draft CoCP sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme to protect groundwaters. All above ground temporary works within construction compounds are included in design and mitigated by the draft CoCP.

3.1.4 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 2.

3.1.5 In support of the groundwater impact assessment presented in Table 2, further detail is provided in Section 3.2 to Section 3.6 to demonstrate the methodology and assumptions used in relation to cuttings (including tunnel portals), viaducts and overbridges and tunnels of the Proposed Scheme. The locations of these elements are shown in Volume 2, MA07 Map Book, Map Series CT-05 and CT-06.

Table 2: Summary of potential impacts on groundwater receptors

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 (aquifers)									
Alluvium – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions Deeper excavations (>1mbgl) including: • Palatine Road vent shaft	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
			Dewatering during construction of the vent shafts has the potential to affect groundwater flow (see Section 3.5).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
River terrace deposits – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
			The vent shaft is not located in the river terrace deposits and the proposed use of	Magnitude of impact – Negligible	None required though the draft CoCP will be	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	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
		Deeper excavations (>1mbgl) including: • Palatine Road vent shaft	diaphragm walls will reduce any impacts on local groundwater levels.	Significance of effect – Negligible, not significant	implemented throughout construction.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Shirdley Hill Sand Formation – Secondary A aquifer	Moderate	None	This unit is not crossed by Proposed Scheme in this community area. Although it may be hydraulically connected to other superficial deposits or underlying bedrock, it is not expected to be impacted by works.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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	None
Glaciofluvial deposits – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
		Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
			Dewatering during construction of the vent shafts has the potential to affect groundwater flow (see Section 3.5).	Magnitude of impact – Minor Significance of effect – Minor, not significant	The proposed use of secant walls through the superficial deposits will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Glaciofluvial ice contact deposits – Secondary A aquifer	Moderate	Deeper excavations (>1mbgl) including: • Birchfields Road vent shaft	The vent shaft is not located in the glaciofluvial ice contact deposits and the proposed methodology that limits external dewatering will reduce any impacts on local groundwater levels.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
	Moderate		The temporary works have the potential to affect groundwater flow and quality,	Magnitude of impact – Minor	None required though the draft CoCP will be	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	Construction (temporary)

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
Glaciofluvial sheet deposits – Secondary A aquifer		Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft • Wilmslow Road vent shaft	although this is likely to be localised and temporary.	Significance of effect – Minor adverse, not significant	implemented throughout construction.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
			Dewatering during construction of the vent shafts has the potential to affect groundwater flow (see Section 3.5).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed use of secant walls through the superficial deposits will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Glacial till – Secondary (Undifferentiated) aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
		Deeper excavations (>1mbgl) including: • Manchester tunnel south porous portal • Manchester tunnel north porous portal • Ardwick South cutting retaining wall • Ardwick box structure • Ardwick North cutting retaining wall	The below ground features, such as cuttings, may alter groundwater flow (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
		Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft • Wilmslow Road vent shaft • Birchfields Road vent shaft	The below ground features of the vent shafts may alter groundwater flow. Dewatering during construction of the vent shaft may also act to alter flow (see Section 3.5).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed use of secant walls through the superficial deposits will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	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 – Sidmouth Mudstone Formation – Bollin	Moderate	Above ground elements and shallow excavation (<1mbgl) including:	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	Construction (temporary)

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
Mudstone Member – Secondary B aquifer		• ground level track and roads • temporary works such as stockpiles and compounds		Significance of effect – Moderate adverse, significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
		Deeper excavations (>1mbgl) including: • Manchester tunnel south porous portal • Manchester tunnel	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and 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)
			The below ground features, including the Manchester tunnel may alter groundwater flow (see Section 3.4).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Mercia Mudstone Group – Tarporley Siltstone Formation – Secondary B aquifer	Moderate	Deeper excavations (>1mbgl) including: • Manchester tunnel • Altrincham Road vent shaft	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and 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)
			Dewatering during construction of the vent shaft and tunnel may act to alter groundwater flow (see Section 3.4 and 3.5).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (temporary)
			The permanent below ground features of the vent shaft and tunnel may alter groundwater flow (see Section 3.4 and 3.5).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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 (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
Sherwood Sandstone Group – Helsby Sandstone Formation – Principal aquifer	High	Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and temporary.	Magnitude of impact – Major Significance of effect – Major 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)
			The below ground features of Manchester tunnel may alter groundwater flow (see Section 3.4).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Sherwood Sandstone Group – Wilmslow Sandstone Formation – Principal aquifer	High	Deeper excavations (>1mbgl) including: • Palatine Road vent shaft	Dewatering during construction of the vent shafts may temporarily act to alter local groundwater flow (see Section 3.5).	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			There is a low risk that dewatering during construction of the vent shafts may draw in poor quality groundwater (see Section 3.5).	Magnitude of impact – Major Significance of effect – Major adverse, significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only) thus removes the risk of saline upwelling. Due to the proximity of the vent shaft to the River Mersey, diaphragm walls are included in design to mitigate the additional risk of uncontrolled inflows.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Monitoring of groundwater quality before and during dewatering. If a significant change in water quality occurs during dewatering, a revised construction plan will be agreed and implemented.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
		Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages	The presence of the vent shaft and tunnel could alter groundwater flow, but they are of small dimensions compared to the extent and depth of the aquifer.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible	Construction (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
		• Palatine Road vent shaft • Wilmslow Road vent shaft		Significance of effect – Negligible, not significant				Significance of effect – Negligible, not significant	
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Sherwood Sandstone Group – Chester Formation – Principal aquifer	High	Deeper excavations (>1mbgl) including: • Wilmslow Road vent shaft	Dewatering during construction of the vent shaft may temporarily act to alter local groundwater flow (see Section 3.5).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Proposed methodology only allows internal dewatering at Wilmslow Road vent shaft and avoidance measures (i.e. use of ejector wells and injection grouting) will be implemented during construction to reduce impact on groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages • Wilmslow Road vent shaft	There is a low risk that dewatering during construction of the vent shafts may draw in poor quality groundwater (see Section 3.5).	Magnitude of impact – Major Significance of effect – Major adverse, significant	Proposed methodology only allows internal dewatering at Wilmslow Road vent shaft and avoidance measures (i.e. injection grouting) will be implemented during construction to reduce impact on groundwater flow and saline upwelling.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Monitoring of groundwater quality before and during dewatering. If a significant change in water quality occurs during dewatering, a revised construction plan will be agreed and implemented.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
			The below ground features of the Manchester tunnel may alter groundwater flow (see Section 3.4).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)

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
		Deeper excavations (>1mbgl) including: • Ardwick North cutting retaining wall	There is significant thickness of glacial till overlying the Sherwood Sandstone Group in this area. Below ground features will only extend into the glacial till that will protect the Sherwood Sandstone in terms of both groundwater flow and quality.	Magnitude of impact – Negligible Significance of effect –Negligible, not significant	None required though the draft 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)
			Potential impacts from cutting dewatering are assessed as negligible (see Section 3.2).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Cumbrian Coast Group – Manchester Marls Formation – Secondary B aquifer	Moderate	Deeper excavations (>1mbgl) including: • Ardwick South cutting retaining wall • Ardwick box structure • Ardwick North cutting retaining wall	The temporary works have the potential to affect groundwater flow and quality, although this is likely to be localised and 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)
			The Ardwick south cutting will remove part of the glacial till over the aquifer, creating a direct pathway into the Cumbrian Coast Group over less than 30m distance. Considering the extent of the Cumbrian Coast aquifer, the effect on the aquifer in terms of groundwater quality is assessed as negligible (see Section 3.2).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
			There is significant thickness of glacial till overlying the Cumbrian Coast Group beneath the Ardwick box structure and Ardwick North cutting retaining wall. Below ground features will only extend into the glacial till that will protect the Cumbrian Coast Group in terms of groundwater flow and quality.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
		Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages • Manchester tunnel north porous portal	The below ground features, including the Manchester tunnel and the Manchester tunnel North portal, may alter groundwater flow.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)

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
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Appleby Group – Collyhurst Sandstone Formation – Principal aquifer	High	Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages • Birchfields Road vent shaft • Manchester tunnel north porous portal • Ardwick South cutting retaining wall	Dewatering during construction of the vent shafts may temporarily act to alter groundwater flow (see Section 3.5).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Proposed methodology only allows internal dewatering at Birchfields Road vent shaft and avoidance measures (i.e. injection grouting) will be implemented during construction to reduce impact on groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			There is a low risk that dewatering during construction of the vent shaft may draw in poor quality groundwater (see Section 3.5).	Magnitude of impact – Major Significance of effect – Major adverse, significant	Proposed methodology only allows internal dewatering at Birchfields Road vent shaft and avoidance measures (i.e. injection grouting) will be implemented during construction to reduce impact on groundwater flow and saline upwelling.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Monitoring of groundwater quality before and during dewatering. If a significant change in water quality occurs during dewatering, a revised construction plan will be agreed and implemented.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
			The below ground features may permanently alter groundwater flow (see Sections 3.2, 3.3, and 3.5).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	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)
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
			The Manchester tunnel north porous portal and Ardwick South cutting will remove part of the glacial till over the aquifer, creating a direct pathway into the Appleby Group. Below ground features	Magnitude of impact – Minor	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	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 extend into the Appleby aquifer that may affect the aquifer in terms of groundwater quality (see Sections 3.2 and 3.3).	Significance of effect – Minor adverse, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Warwickshire Group – Halesowen Formation – Secondary A aquifer	Moderate	Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages • Birchfields Road vent shaft	Dewatering during construction of the vent shaft may temporarily act to alter groundwater flow (see Section 3.5).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Proposed methodology only allows internal dewatering at Wilmslow Road vent shaft and avoidance measures (i.e. injection grouting) will be implemented during construction to reduce impact on groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The below ground features, including the Manchester tunnel, and vent shafts may alter groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
			There is a low risk that dewatering during construction of the vent shaft may draw in poor quality groundwater (see Section 3.5).	Magnitude of impact – Major Significance of effect – Moderate adverse, significant	Proposed methodology only allows internal dewatering at Birchfields Road vent shaft and avoidance measures (i.e. injection grouting) will be implemented during construction to reduce impact on groundwater flow and saline upwelling.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Monitoring of groundwater quality before and during dewatering. If a significant change in water quality occurs during dewatering that could affect the status of the aquifer, a revised construction plan will be agreed and implemented.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Warwickshire Group – Etruria Formation – Secondary A aquifer	Moderate	Deeper excavations (>1mbgl) including: • Manchester tunnel and cross passages • Birchfields Road vent shaft	Dewatering during construction of the vent shaft may act to alter groundwater flow (see Section 3.5).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)

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
			The below ground features, including the Manchester tunnel, and vent shafts may alter groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
			Construction of cross passages will be short term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Warwickshire Group – Halesowen Formation – Holt Town Sandstone Bed – Secondary A aquifer Warwickshire Group – Halesowen Formation – Great Mine Limestone – Secondary A aquifer Pennine Coal Measures Group – Pennine Upper Coal Measures Formation – Secondary A aquifer	Moderate	None	These units are not crossed by Proposed Scheme in this community area. Although they may be hydraulically connected to other formations, they are not expected to be impacted by the works in proximity to these units.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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	None
Abstractions									
Borehole at Didsbury Golf Club, Northenden, Wythenshawe 2569015006	Moderate	Deeper excavations (>1mbgl) including: • Palatine Road vent shaft	The temporary works will affect groundwater flow and quality during dewatering for the construction of the vent shaft, although this is likely to be localised and temporary (see Section 3.5).	Magnitude of impact – Major Significance of effect – Moderate adverse, significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Major Significance of effect – Moderate adverse, significant	Further investigation and monitoring. If detailed investigations by the nominated undertaker confirm a risk of temporary impact on the abstraction, mitigation measures will be agreed with the licence holder.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

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
Discharges to groundwater									
There are no discharges to groundwater in the study area.									
Groundwater – surface water interactions									
Potential spring at Blackcarr Wood south, Baguley	High	Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft • Manchester tunnel	The detailed assessment (see Section 4) shows that this potential spring is outside of the calculated dewatering zone of influence, and therefore the potential spring will not be affected by any dewatering of the Mercia Mudstone Group.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Potential spring at Gib Lane Wood east, Baguley Potential sink at Gib Lane Wood south, Baguley	High	Deeper excavations (>1mbgl) including: • Manchester tunnel	These features are located over 350m north of land required for the construction of the Proposed Scheme and is outside of the zone of influence of any below ground works. The potential features are not expected to be impacted by the Proposed Scheme.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Potential sink at Stenner Lane Museum & Art Gallery	High	None	This potential spring is located 1km south-east of the Proposed Scheme and is outside of the zone of influence of below ground works. This feature is not expected to be impacted by the Proposed Scheme.	Magnitude of impact – Negligible Significance of effect –Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None
Fairywell Brook	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions	The temporary works have the potential to affect groundwater quality although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft 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)
		Deeper excavation (>1mbgl) including: • Manchester tunnel south porous portal	The detailed assessment (see Section 3.3) shows that this feature is within the zone of influence and although groundwater may be intercepted that would otherwise flow to this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Baguley Brook	Moderate	Above ground elements and shallow excavation (<1mbgl) including:	The temporary works have the potential to affect groundwater quality although this is likely to be localised and temporary.	Magnitude of impact – Minor	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible	None required	Magnitude of impact – Negligible	Construction (temporary)

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
		• ground level track and roads • temporary works such as stockpiles and compounds		Significance of effect – Minor adverse, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
		Deeper excavation (>1mbgl) including: • Altrincham Road vent shaft	The detailed assessment (see Section 3.5) shows that this feature is within the potential dewatering zone of influence and groundwater may be intercepted that would otherwise flow to this watercourse.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Use of secant piles during construction of the vent shaft will reduce any impacts on groundwater flow in the superficial deposits potentially supporting this water feature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Mill Brook	Moderate	None	No works directly adjacent to the watercourse so limited potential for any hydraulic connection to this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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	None
Tributary of Baguley Brook	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds • utilities diversions	The temporary works have the potential to affect groundwater quality although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
		Deeper excavation (>1mbgl) including: • Altrincham Road vent shaft	The detailed assessment (see Section 3.5) shows that this feature is within the potential dewatering zone of influence and groundwater may be intercepted that would otherwise flow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Use of secant piles during construction of the vent shaft will reduce any impacts on groundwater flow in the superficial deposits potentially supporting this water feature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
River Mersey	Very high	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds	The temporary works have the potential to affect groundwater quality although this is likely to be localised and temporary.	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)

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
		Deeper excavation (>1mbgl) including: • Palatine Road vent shaft	The detailed assessment (see Section 3.5) shows that this feature is within the potential dewatering zone of influence and groundwater may be intercepted that would otherwise flow to this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of River Mersey 1 Tributary of River Mersey 3	Moderate	Deeper excavation (>1mbgl) including: • Palatine Road vent shaft	The detailed assessment (see Section 3.5) shows that these features are within the potential dewatering zone of influence and groundwater may be intercepted that would otherwise flow to these watercourses.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of River Mersey 2	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles and compounds	The temporary works have the potential to affect groundwater quality although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft 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)
		Deeper excavation (>1mbgl) including: • Palatine Road vent shaft	The detailed assessment (see Section 3.5) shows that this feature is within the potential dewatering zone of influence and groundwater may be intercepted that would otherwise flow to this watercourse.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			There is a low risk that dewatering during construction of the vent shaft may draw in poor quality groundwater that might then be discharged to Tributary of River Mersey 2 (see Section 3.5).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed use of full depth diaphragm walls will reduce requirement for dewatering (internal dewatering only). Dewatering will be in small quantities and temporary in nature.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Red Lion Brook	Low	None	No works directly adjacent to the watercourse so limited potential for any hydraulic connection to this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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	None

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
Cringle Brook Fallowfield Brook Gore Brook Tributary of Cringle Brook 1	Moderate	Deeper excavation (>1mbgl) including: • Birchfields Road vent shaft	The detailed assessment (see Section 3.5) shows that these features are within the potential dewatering zone of influence of the vent shaft. The watercourses may be fully or predominantly in culvert within the dewatering zone of influence. However, there is potential for leakage from any open sections of watercourse, or from the culverts, if the water table in adjacent superficial deposits is affected by the dewatering.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Construction methodology only allows methods which exclude external dewatering during construction will reduce any impacts on groundwater flow in the superficial deposits potentially supporting these water features.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Corn Brook	Low	Deeper excavations (>1mbgl) including: • Ardwick South cutting retaining wall • Ardwick box structure • Ardwick North cutting retaining wall	The cuttings assessment (see Section 3.2) shows that this feature is within the maximum zone of influence for the cutting. However, watercourse is in culvert in the study area and therefore no impact is expected on river flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft 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)
Tributary of Platt Brook 1	Low	Deeper excavation (>1mbgl) including: • Birchfields Road vent shaft	The detailed assessment (see Section 3.5) shows that this feature is within the potential dewatering zone of influence of the vent shaft. The watercourse may be fully or predominantly in culvert within the dewatering zone of influence. However, there is potential for leakage from any open sections of watercourse, or possibly from the culverts, if the water table in adjacent superficial deposits is affected by the dewatering.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Construction methodology only allows methods which exclude external dewatering during construction will reduce any impacts on groundwater flow in the superficial deposits potentially supporting these water features.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

3.2 Impact on groundwater from cuttings

3.2.1 Summary parameters for each cutting is presented below in Table 3.

3.2.2 Where the groundwater elevation lies above the base of the cutting the likely maximum zone of influence from dewatering of the cutting has been undertaken. In the case that the groundwater level is not known, the groundwater level is assumed to be at surface and a detailed assessment is undertaken accordingly.

3.2.3 Assessment of the likely maximum zone of influence from dewatering of the cuttings has been made using Sichardt's formula as set out in the SMR Technical Note: Groundwater assessment.

3.2.4 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.

3.2.5 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. Maximum drainage invert below track level is estimated at 3.15m.

3.2.6 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.

Ardwick South cutting retaining wall, Ardwick box structure and Ardwick North cutting retaining wall

Table 3: Summary of the parameters for the groundwater assessment of Ardwick South cutting retaining wall, Ardwick box structure and Ardwick North cutting retaining wall

Cutting retaining walls and box structure parameters	Parameter details
Length (m)	520
Maximum depth (m)	10 to top of rail (16.3 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Appleby Group – Collyhurst Sandstone Formation (Principal aquifer)
Lowest level of drainage invert along track (metres above ordnance datum: mAOD)	32.2
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Appleby Group – Collyhurst Sandstone (Principal aquifer) Cumbrian Coast Group – Manchester Marls Formation (Secondary B aquifer) Sherwood Sandstone Group – Chester Formation (Principal aquifer) Corn Brook River Medlock Allocations MA07/111, MA07/110, MA08/038 and MA08/129[4]

3.2.7 The cuttings would penetrate through the glacial till Secondary (Undifferentiated) aquifer, and into the Appleby Group (Collyhurst Sandstone Formation) Principal aquifer, the Cumbrian Coast Group (Manchester Marls Formation) Secondary B aquifer and the Sherwood Sandstone Group (Chester Formation) Principal aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area. It has therefore been conservatively assumed that groundwater levels within the glacial till and the bedrock aquifers are at ground level and that groundwater flow within the glacial till, Collyhurst Sandstone Formation, Manchester Marls Formation and Chester Formation may be affected by the cutting. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.8 As defined above, the zone of drawdown has been calculated assuming the cutting is an open cutting without retaining walls. Assuming a hydraulic conductivity value of $3.00x10^{-4}$m/s for the glacial till[5], $1.16x10^{-4}$m/s for the Appleby Group[6] and the Sherwood Sandstone Group and $2.72x10^{-5}$m/s for the Cumbrian Coast Group[7], the zone of drawdown (also referred to as the zone of influence) is estimated to extend of up to 333m in the glacial till. This is based on a maximum cutting depth of 16.3m from ground level to track drainage invert, and a rest water level at ground level. The zone of influence is not extended in the bedrock aquifers. The cuttings will be constructed as an open cutting with secant piled retaining walls. Part of the cutting will be constructed as a box structure.

3.2.9 The Sherwood Sandstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum cutting depth is assessed as negligible, leading to negligible effect which is not significant in terms of impact on the Principal aquifer. The below ground structures extend into the top of the Appleby Group and Cumbrian Coast Group. On the scale of the cuttings compared to the extent of the bedrock aquifers, the changes to groundwater level are assessed as a minor impact, leading to a minor effect which is not significant.

3.2.10 The glacial till is partially penetrated by the cuttings. Assuming that the groundwater flow direction in the glacial till follows topography, groundwater will flow towards the south-west. As this is not parallel to the cutting, the cutting is likely to form a partial barrier to groundwater flow in the area, leading to a risk of groundwater flooding on the upgradient side. This is assessed to be a moderate impact, leading to a moderate effect which is significant (refer to the Flood risk assessment, Volume 5, Appendix WR-005-0MA07.

3.2.11 Corn Brook is located within the calculated zone of influence; however, this watercourse is in a lined culvert through the study area. Therefore, the potential impact on this watercourse is assessed as negligible, leading to negligible effect which is not significant. The River Medlock is located within the adjacent Manchester Piccadilly Station area (MA08). While the river is outside of the radius of influence but as it is located

[4] Further details of these planning allocations can be found in Volume 5: Appendix CT-004-00000, Planning data.

[5] On a precautionary basis, high-end sand and gravel conductivity values are assumed for glacial till to allow for potential presence of middle sands: Hydraulic conductivity from Domenico, P.A and Schwartz, F. W. (1990), *Physical and Chemical Hydrogeology*. John Wiley & Sons.

[6] Geometric mean value for PT sandstone from Allen, D. J et al. *The physical properties of major aquifers in England and Wales*. British Geological Survey Technical Report WD/97/34.

[7] Jones, H K, Morris, B L, Cheney, C S, Brewerton, L J, Merrin, P D, Lewis, M A, MacDonald, A M, Coleby, L M, Talbot, J C, McKenzie, A A, Bird, M J, Cunningham, J, and Robinson, V K. (2000), *The physical properties of minor aquifers in England and Wales*. British Geological Survey Technical Report, WD/00/4. 234pp, Environment Agency R&D Publication 68.

downgradient of the cutting, the groundwater baseflow to this watercourse may be impacted. There is no drainage incorporated into this part of the route and as such the River Medlock may receive reduced baseflow. However, considering the scale of this watercourse, the impact of the groundwater interception on river flow is assessed as negligible, leading to a negligible effect which is not significant.

3.2.12 The below ground structures also have the potential to obstruct groundwater flow within the area of several allocations, MA07/111, MA07/110, MA08/038 and MA08/129[4], however the reduction in flow is unlikely to impact on these allocations. Refer to the Flood risk assessment, Volume 5: Appendix WR-005-0MA07) for the impact of potential groundwater flooding on the allocations.

3.3 Impact on groundwater from the tunnel approaches

3.3.1 An initial characterisation for tunnel approaches is undertaken based on depth and groundwater level to determine if the groundwater table will be intersected. These initial assessments are shown for each portal in Table 4 to Table 5.

3.3.2 Where the groundwater elevation lies above the base of the portal, a detailed assessment of the likely maximum zone of influence from dewatering of the portal has been undertaken. In the case that the groundwater level is not known, the groundwater level is assumed to be at surface and a detailed assessment is undertaken accordingly.

3.3.3 Assessment of the likely maximum zone of influence from dewatering of the tunnel approaches has been made using Sichardt's formula as set out in the SMR Technical Note: Groundwater assessment.

3.3.4 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.

3.3.5 Tunnel approaches are assumed to be open and any permanent works such as retaining walls or drainage measures do not form part of the quantitative assessment. Maximum drainage invert below track level is estimated at 3.15m.

3.3.6 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.

Manchester tunnel south porous portal

Table 4: Summary of the parameters for the groundwater assessment of Manchester tunnel south porous portal

Portal parameters	Parameter details
Length (m)	50
Maximum depth (m)	15.0 to top of rail (17.5 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member) (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	45.2
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member) (Secondary B aquifer) Fairywell Brook

3.3.7 The south porous portal would penetrate the glacial till Secondary (Undifferentiated) aquifer and the Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member) Secondary B aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area. It has therefore been conservatively assumed that groundwater levels within the glacial till and Mercia Mudstone Group are at ground level and that groundwater flow within the glacial till and Mercia Mudstone Group may be affected by the portal. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.3.8 Assuming a hydraulic conductivity value of 3.0×10^{-4}m/s for the glacial till[5] the lateral extent of drawdown (also referred to as the zone of influence) is estimated to extend up to 212m. This is based on a maximum portal depth of 17.5m from ground level to track drainage invert, and a rest water level at ground level.

3.3.9 Manchester tunnel south portal will fully penetrate the glacial till and will extend into the top of the underlying Mercia Mudstone Group. However, the lateral extent of drawdown is not extended in the bedrock aquifer. Assuming a hydraulic conductivity value of $2.72x10^{-5}$m/s for the Mercia Mudstone Group[8], the lateral extent of drawdown is in the Mercia Mudstone Group aquifer is up to 160m.

3.3.10 The Mercia Mudstone Group extends more than 50m below the portal depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum portal depth are assessed as negligible, leading to a negligible effect which is not significant in terms of the Secondary B aquifer. There are likely to be thin groundwater bearing horizons within the Mercia Mudstone Group that may not be laterally extensive. Further ground investigation and monitoring is required to confirm groundwater levels in this location, and whether there are any more permeable bands likely to be impacted by the portal. This will inform the detailed design and management of groundwater during construction.

3.3.11 Assuming the groundwater flow direction in the glacial till follows topography, groundwater will flow towards the north-west. The portal is aligned perpendicular to the groundwater flow direction and, as a result, is likely to form a barrier to groundwater flow in the glacial till. Whilst there may be local changes in groundwater level, on the scale of the glacial till aquifer, the impact is assessed to be negligible on the Secondary (Undifferentiated) aquifer, leading to a negligible effect which is not significant.

3.3.12 Fairywell Brook is located within the calculated zone of influence of Manchester tunnel south porous portal and groundwater that would otherwise discharge into this watercourse may be intercepted by the portal. The watercourse will receive some rainfall-runoff flow from the facilities drainage network of the Proposed Scheme, but this will not compensate for loss of groundwater baseflow. As such, a short stretch of the watercourse, of approximately 50m, will be impacted by reduced baseflow. However, considering the scale of this watercourse compared to the area of reduced flow, the impact of the groundwater interception on river flow is assessed as negligible, leading to a negligible effect which is not significant.

Manchester tunnel north porous portal

Table 5: Summary of the parameters for the groundwater assessment of Manchester tunnel north porous portal

Portal parameters	Parameter details
Length (m)	50
Maximum depth (m)	19.0 to top of rail (19.7 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Appleby Group – Collyhurst Sandstone Formation (Principal aquifer)
Lowest level of drainage invert along track (mAOD)	31.3
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Appleby Group – Collyhurst Sandstone Formation (Principal aquifer) Corn Brook Allocations MA07/111, MA07/110 and MA08/129[4]

3.3.13 The north porous portal would penetrate the glacial till Secondary (Undifferentiated) aquifer and the Appleby Group (Collyhurst Sandstone Formation) Principal aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area. It has therefore been conservatively assumed that groundwater levels within the glacial till and Collyhurst Sandstone Formation are at ground level and that groundwater flow within the glacial till and Collyhurst Sandstone Formation may be affected by the portal. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.3.14 Assuming a hydraulic conductivity value of $3.0x10^{-4}$m/s for the glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) is estimated to extend up to 306m. This is based on a maximum portal depth of 19.7m from ground level to the track drainage invert, and a rest water level at ground level. The Manchester tunnel north porous portal will fully penetrate the glacial till and will extend into the top of the underlying Appleby Group. The lateral extent of drawdown is extended in the bedrock. Assuming a hydraulic conductivity value of $1.16x10^{-4}$m/s for the Appleby Group[6], the lateral extend of drawdown in the Appleby Group aquifer is estimated to extend a distance of up to 372m.

3.3.15 The bedrock extends more than 50m below the portal depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum portal depth are assessed as negligible, leading to negligible effect which is not significant in terms of impact on these aquifers.

[8] Based on the high-end value for bulk testing within the Mercia Mudstone Group. Hobbs, P. R. N et al. (2002), *Engineering geology of British rocks and soils – Mudstones of the Mercia Mudstone Group*. British Geological Survey, Research Report RR/01/02.

3.3.16 Assuming the groundwater flow direction in the glacial till follows topography, groundwater will flow towards the south to south-west. The portal is aligned approximately perpendicular to the groundwater flow direction and, as a result, is likely to form a barrier to groundwater flow in the glacial till. Whilst there may be local changes in groundwater level, on the scale of the glacial till aquifer in the area the impact is assessed to be negligible on the Secondary (Undifferentiated) aquifer, leading to a negligible effect which is not significant.

3.3.17 Corn Brook is located within the calculated zone of influence and groundwater that would otherwise discharge into this watercourse may be intercepted. However, the Corn Brook is culverted though the study area and therefore, it is unlikely to receive groundwater flow in this area. The impact of the portal on the river flow is therefore assessed as negligible, leading to a negligible effect which is not significant.

3.3.18 The below ground structures of the north porous portal have the potential to obstruct groundwater flow within the area of several allocations, MA07/111, MA07/110 and MA08/129[4], however considering the scale of the north porous portal, the reduction in flow is unlikely to impact on the allocations.

3.4 Impact on groundwater from the tunnel

3.4.1 The Manchester tunnel comprises twin bored tunnels 12.8km in length, each 7.55m internal diameter, and will run from the Manchester tunnel south porous portal to the Manchester tunnel north porous portal. The bedrock in the Davenport Green to Ardwick area is highly variable due to extensive faulting. Tunnelling is within bedrock that includes:

- Mercia Mudstone Group (Sidmouth Mudstone Formation – Bollin Mudstone Member) Secondary B aquifer;
- Mercia Mudstone Group (Tarporley Siltstone Formation) Secondary B aquifer;
- Sherwood Sandstone Group (Helsby Sandstone Formation) Principal aquifer;
- Sherwood Sandstone Group (Wilmslow Sandstone Formation) Principal aquifer;
- Sherwood Sandstone Group (Chester Formation) Principal aquifer;
- Cumbrian Coast Group (Manchester Marls Formation) Secondary B aquifer;
- Appleby Group (Collyhurst Sandstone Formation) Principal aquifer;
- Warwickshire Group (Halesowen Formation) Secondary A aquifer; and
- Warwickshire Group (Etruria Formation) Secondary A aquifer.

3.4.2 The Manchester tunnel will be constructed using an earth pressure balance (EPB) TBM through the bedrock aquifer. The TBM is designed so the tunnel is lined behind the TBM as the TBM advances through the ground. The lining is fully constructed using a precast concrete unit behind the face of the excavation. Cement grout is injected behind the tunnel lining to fill the annulus between the lining and the excavated ground. The section between the constructed tunnel lining and the face of the excavation is protected by a 'steel can' that is effectively watertight. As the TBM advances, the excavation face in front of the tunnel will also be pressurised to balance the groundwater pressure and the soil pressure. The cross passages between the twin bore tunnels will be constructed with the aid of ground improvement (such as injection grouting), where required, to avoid groundwater ingress. Therefore, no dewatering is expected during construction of the Manchester tunnel.

3.4.3 The tunnel is designed to be watertight although some minimal leakage is likely. The potential loss of groundwater into the tunnel is considered negligible with negligible impact to existing groundwater levels in the long-term, leading to a negligible effect which is not significant.

3.4.4 Construction of the tunnel will create an extended cylinder of no flow through the Mercia Mudstone and Sherwood Sandstone aquifers. Hydraulic conductivity of the aquifer in the area of the tunnel lining will also decrease as a result of grouting during construction. However, as each tunnel bore has a diameter of 7.55m, in aquifers that have a large areal extent and extend vertically below the tunnel for at least 100m, and in some places significantly more. Any changes in groundwater level due to a partial barrier to flow created by the tunnel will be highly localised. The tunnel will therefore have a negligible impact on groundwater throughflow and on the Mercia Mudstone and Sherwood Sandstone aquifers overall, leading to negligible effect which is not significant.

3.4.5 The Appleby and Warwickshire Groups, as well as parts of the Cumbrian Coast Group, are of much smaller areal extent than the Mercia Mudstone and Sherwood Sandstone. This is due to extensive faulting creating fault blocks of smaller areal extent in these aquifers, although the fault blocks do still extend vertically below the tunnel for at least 100m, and in some places significantly more. The tunnel, creating an extended cylinder of no flow, may have a minor impact on groundwater flow in the Appleby, Warwickshire and Cumbrian Coast Group aquifers. However, any changes in groundwater level due to a partial barrier to flow created by the tunnel are expected to be localised. This leads to a moderate effect which is significant for the Appleby Group, and a minor effect which is not significant for the Warwickshire Group and the Cumbrian Coast Group.

3.4.6 Application of the draft CoCP will ensure materials and fluids used during construction are managed so there is a negligible impact on groundwater quality and associated receptors.

3.5 Impact on groundwater from the tunnel vent shafts

3.5.1 Summary parameters for each vent shaft are shown in Table 6 to Table 9.

3.5.2 Where the groundwater elevation lies above the base of the vent shaft, a detailed assessment of the likely maximum zone of influence from dewatering of the vent shaft has been undertaken. In the case that the groundwater level is not known, the groundwater level is assumed to be at surface and a detailed assessment is undertaken accordingly.

Altrincham Road vent shaft

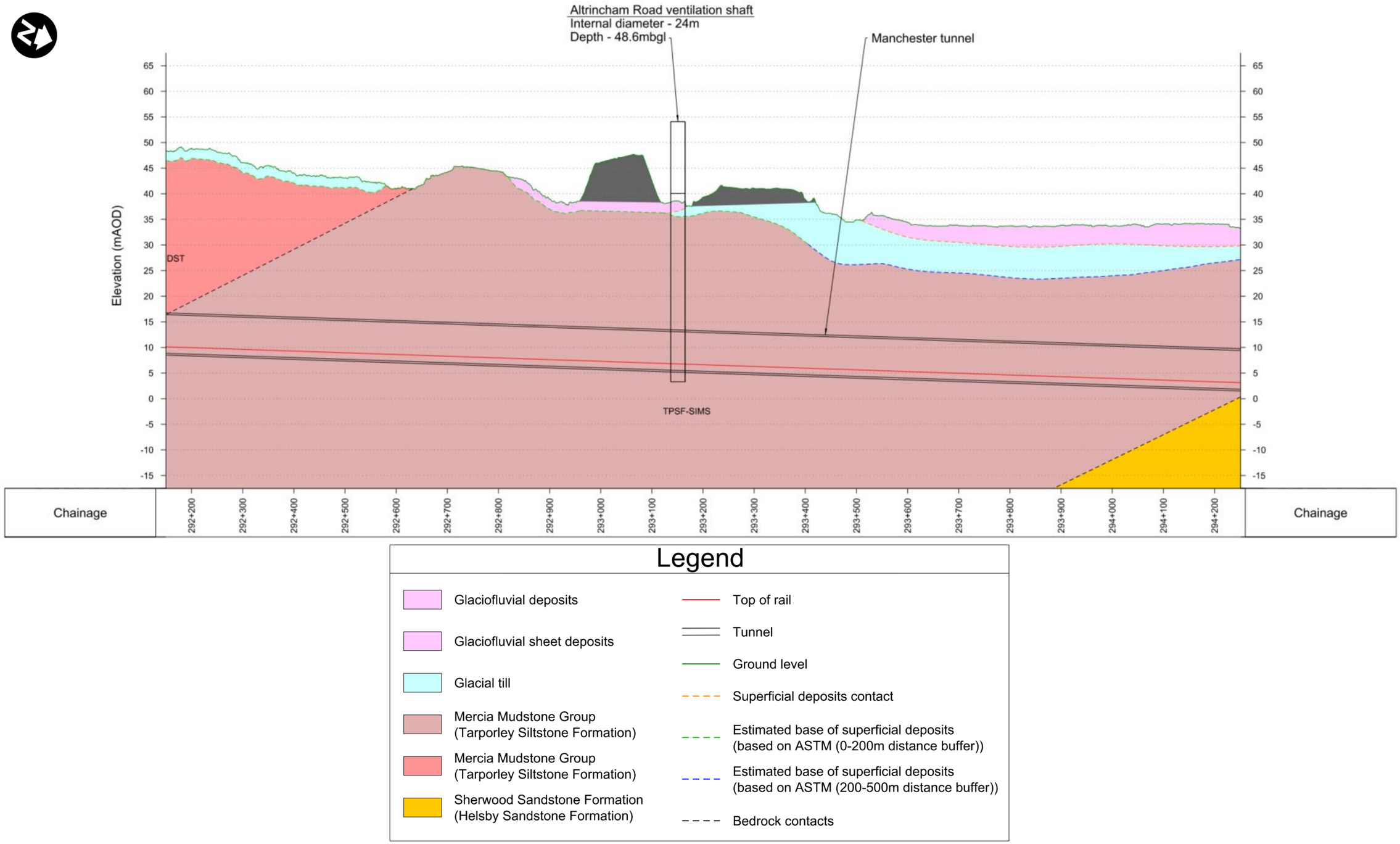
Table 6: Summary of the parameters for the groundwater assessment of Altrincham Road vent shaft

Vent shaft parameters	Parameter details
Diameter (m)	24
Maximum depth (m)	48.6
Strata intercepted	Glaciofluvial sheet deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group (Tarporley Siltstone Formation) (Secondary B aquifer)
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Glaciofluvial deposits (Secondary A aquifer) Glaciofluvial sheet deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group (Tarporley Siltstone Formation) (Secondary B aquifer) Baguley Brook Tributary of Baguley Brook Blackcarr Wood and Baguley Bottoms Site of Biological Interest (SBI) Round Wood SBI and Ancient Woodland Wythenshawe Park and Gib Lane Wood Local Nature Reserve (LNR) and SBI

3.5.3 The vent shaft would penetrate the glaciofluvial sheet deposits (Secondary A) aquifer, the glacial till Secondary (Undifferentiated) aquifer and the top of the Mercia Mudstone Group Secondary B aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area for the superficial or bedrock aquifers. It has therefore been conservatively assumed that groundwater levels within the glaciofluvial sheet deposits, glacial till and the Mercia Mudstone Group are at ground level and that groundwater flow within the glaciofluvial sheet deposits, glacial till and the Mercia Mudstone Group may be affected by the vent shaft dewatering. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.5.4 The vent shaft will be constructed using secant piles through the glaciofluvial sheet deposits and glacial till and embedded into the Mercia Mudstone. Where the shaft penetrates the Mercia Mudstone Group, construction will be completed using sprayed concrete lining (SCL) method. A schematic geological cross section of the Altrincham Road vent shaft is provided in Figure 1.

Figure 1: Geological cross section of the Altrincham Road vent shaft



Adapted from Crewe to Manchester MA07/M003 Geotechnical Plan and Profile Chainage drawing (2DE01-MWJ-GT-DGA-M003-360006). Scale H: 1:10,000, V: 1:1000. ASTM - American Society for Testing and Materials

3.5.5 The proposed methodology (construction of secant pile walls in the superficial deposits) will limit the requirement for dewatering during construction of the section of the vent shaft through the superficial deposits. However, any required dewatering of the bedrock aquifer may lead to a reduction or reversal in upward leakage from the bedrock to the overlying aquifer in the superficial deposits, if the current groundwater level in the bedrock aquifer is above the groundwater level in the superficial deposits. If, however, the groundwater level in the bedrock aquifer is below the groundwater level in the superficial deposits, the dewatering could produce an increase in leakage to the bedrock. In either case, the groundwater level in the superficial deposits could be reduced locally as a result of the dewatering. Taking into account the location of the vent shaft close to the boundary between glaciofluvial sheet deposits and glacial till where both deposits form only thin near-surface layers, the temporary impact on groundwater levels in the aquifers overall is assessed to be negligible for the superficial deposits, leading to a negligible effect which is not significant.

3.5.6 Baguley Brook (moderate value) and Tributary of Baguley Brook (low value) are located close to Altrincham Road vent shaft and may receive reduced baseflow to the reaches downstream of the Proposed Scheme, although the tributary appears to be in culvert in the immediate vicinity of the shaft. This is assessed as a minor impact to the watercourses leading to a minor adverse effect which is not significant. On a precautionary basis, there may also be a temporary minor impact on any potentially groundwater dependent features in the Blackcarr Wood and Baguley Bottoms SBI that is located close to Baguley Brook (further information in Section 4.1). The impact on other, more distant receptors (including the potentially groundwater dependent habitat at Round Wood SBI and Ancient Woodland and the groundwater dependent habitat at Wythenshawe Park and Gib Lane Wood LNR and SBI) will be negligible, leading to a negligible effect which is not significant.

3.5.7 The vent shaft will penetrate the base of the superficial deposits and extend into the underlying Mercia Mudstone Group (Tarporley Siltstone Formation) bedrock. Assuming a hydraulic conductivity value of $1.00x10^{-5}$m/s for the Mercia Mudstone Group[8], the zone of influence with dewatering to the base of the shaft is calculated as 351m. This zone of influence calculation is based on the assumption that the water level in the Mercia Mudstone is at ground level. The zone of influence does not intercept any of the bedrock zones of influence for the other vent shafts in MA07. The overall period for vent shaft construction in which dewatering will be required during some construction activities is estimated to be just over eight months. This includes the time required for construction of the vent shaft adit at the site. The amount of dewatering will also be reduced within this time by using SCL techniques in a staged and sequentially controlled process, together with ground treatment as considered necessary. The temporary impact of dewatering on groundwater levels and flow in the bedrock should, therefore, be localised and relatively short-term. This dewatering is assessed to have a temporary minor impact on the groundwater level and flow in the Tarporley Siltstone Formation, leading to a minor adverse effect, which is not significant. There is no particular concern regarding the possibility of significant changes in groundwater quality during dewatering in the Tarporley Siltstone Formation and there is no existing known saline water at depth.

3.5.8 As the SCL will be completed shortly after excavation of the shaft and adit, and the aquifer is expected to recover quickly from the impact of dewatering, the permanent effect of the vent shaft on groundwater level and flow in the Mercia Mudstone Group is assessed to be negligible, which is not significant.

3.5.9 A detailed exploratory borehole investigation and groundwater monitoring programme will be undertaken in the area around the vent shaft site, prior to detailed design. The details of this programme that may also include test pumping of boreholes to provide data to improve the assessment of the zone of influence, will be agreed in advance with the Environment Agency. The results of the investigation will be used in a review of the shaft dewatering proposals. Regular monitoring of groundwater levels (and groundwater quality) around the vent shaft site, and at levels in the aquifer below the depth of the vent shaft, will commence before construction in order to establish existing aquifer conditions. Although there is no evidence to suggest that dewatering could give rise to a significant change in groundwater quality in the vicinity of the Altrincham Road vent shaft, if deemed necessary a contingency action plan will be agreed with the Environment Agency, prior to the start of construction, with agreed actions in place if changes in water quality are observed. The monitoring will then continue through the period of construction and into the post-construction period.

Palatine Road vent shaft

Table 7: Summary of the parameters for the groundwater assessment of Palatine Road vent shaft

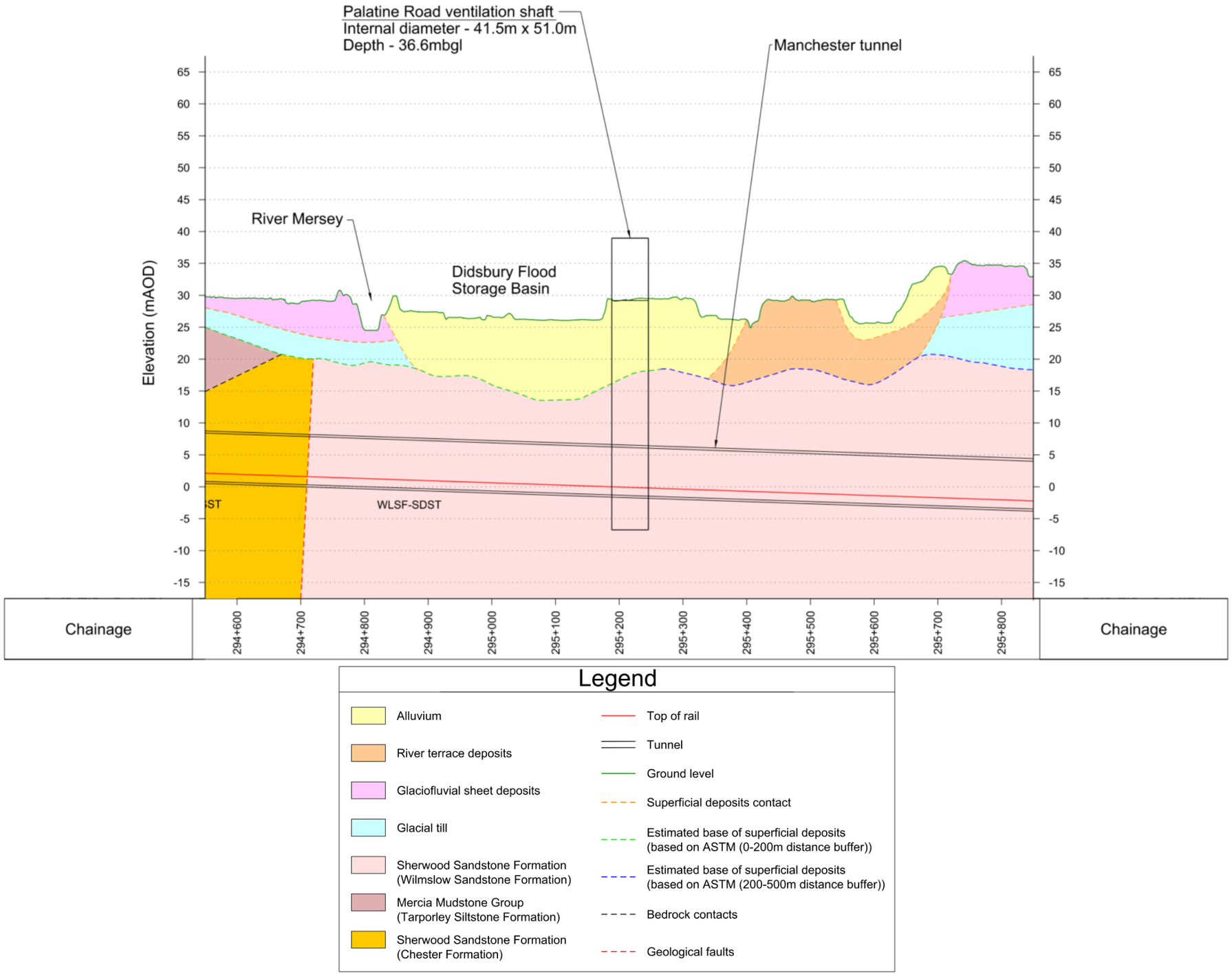
Vent shaft parameters	Parameter details
Diameter (m)	41.5 and 51.0 for the two axes of symmetry of the oval shape of the vent shaft
Maximum depth (m)	36.6
Strata intercepted	Alluvium (Secondary A aquifer) Sherwood Sandstone Group (Wilmslow Sandstone Formation) (Principal aquifer)
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Alluvium (Secondary A aquifer) River terrace deposits (Secondary A aquifer) Glaciofluvial sheet deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group (Tarporley Siltstone Formation) (Secondary B aquifer)

Vent shaft parameters	Parameter details
	Sherwood Sandstone Group (Helsby Sandstone Formation) (Principal aquifer) Sherwood Sandstone Group (Wilmslow Sandstone Formation) (Principal aquifer) Borehole at Didsbury Golf Club, Northenden, Wythenshawe (abstraction licence 2569015006) River Mersey Tributary of River Mersey 1 Tributary of River Mersey 2 Tributary of River Mersey 3 Allocation MA07/299[4] Stenner Woods and Milgate Fields, Didsbury and Fletcher Moss LNR and SBI Wrengate Wood & Heyscroft SBI and Ancient Woodland

3.5.10 The vent shaft would penetrate the alluvium (Secondary A) aquifer and the top of the Sherwood Sandstone Group (Principal) aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area for the alluvium and the Sherwood Sandstone Group. It has therefore been conservatively assumed that groundwater levels within the alluvium and the Sherwood Sandstone Group are at ground level and that groundwater flow within the alluvium and the Sherwood Sandstone Group may be affected by the vent shaft dewatering. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.5.11 The vent shaft will be constructed with full depth diaphragm walls through the alluvium and Sherwood Sandstone to below the base of the shaft. A schematic geological cross section of the Palatine Road vent shaft is provided in Figure 2.

Figure 2: Geological cross section of the Palatine Road vent shaft



Adapted from Crewe to Manchester MA07/M003 Geotechnical Plan and Profile Chainage drawing (2DE01-MWJ-GT-DGA-M003-360007). Scale H: 1:10,000, V: 1:1000. ASTM - American Society for Testing and Materials

3.5.12 The vent shaft will penetrate to the base of the alluvium and extend into the underlying Sherwood Sandstone Group bedrock. The proposed methodology is to use full depth diaphragm walls that will limit the zone of drawdown as only internal dewatering will be required during construction. As such, the zone of influence does not intercept any of the bedrock zones of influence for the other vent shafts in MA07. The temporary impact of internal dewatering on groundwater levels and flow in the bedrock should be short-term as groundwater flow pathways would be sealed once concrete in diaphragm walls is set. Overall, the temporary impact of the vent shaft construction on groundwater levels is assessed to be negligible on the Sherwood Sandstone Group as a whole, leading to a negligible effect which is not significant. The temporary impact on groundwater levels is assessed to be negligible for the superficial deposits, leading to a negligible effect which is not significant.

3.5.13 As indicated in the Water resources baseline data (BID WR-004-0MA07), up-coning of saline groundwater in the Sherwood Sandstone Group aquifer has occurred in the Trafford Park area, located approximately 6.5km north-west of the Palatine Road vent shaft, as a result of high levels of groundwater abstraction from deep boreholes over many years. There is no evidence of up-coning of saline groundwater at depth in the Sherwood Sandstone Group in the vicinity of the Manchester tunnel. Water quality data are available for Borehole at Didsbury Golf Club, Northenden, Wythenshawe (abstraction licence 2569015006) in the same aquifer. This borehole is relatively shallow (37m) and abstraction rates, for spray irrigation, are likely to be quite low overall with the source only used in drier summer periods. This data does not indicate the presence of saline groundwater.

3.5.14 The shaft is relatively shallow in comparison with the affected boreholes in Trafford Park. Due to the use of diaphragm walls, the dewatering required will be kept to a minimum during the period of construction of the shaft section in the aquifer. The use of temporary internal dewatering for the construction of the vent shaft reduces the risk of upwelling of saline water, if present towards the base of the Sherwood Sandstone Group aquifer in this area. This includes reducing the risk of poorer quality groundwater being drawn into the aquifer from underlying formations such as the Collyhurst Sandstone and Coal Measures, or possibly from the Mercia Mudstone, along or across fault boundaries, during dewatering. Therefore, it is unlikely that the temporary dewatering for vent shaft construction would lead to a permanent impact on the water quality in the Sherwood Sandstone Group aquifer. Additionally, taking into account the relative shallow depth and location of the shaft within the Sherwood Sandstone Group aquifer, together with the limited period of dewatering, the risk of an impact on the aquifer is considered to be low. Therefore, it is assessed to be a negligible permanent impact on groundwater quality in the high value Sherwood Sandstone Group in the area, leading to a negligible effect which is not significant.

3.5.15 A detailed exploratory borehole investigation and groundwater monitoring programme will be undertaken in the area around the vent shaft site, prior to detailed design. The geophysical investigations will be tailored to determine likely impacts on groundwater during construction and will be agreed in advance with the Environment Agency. The potential impact of abstraction from the bedrock on groundwater levels in the overlying alluvium could also be assessed. The results of the investigation will be used in a review of the shaft dewatering proposals. Regular monitoring of groundwater levels and groundwater quality around the vent shaft site, and at levels in the aquifer below the depth of the vent shaft, will commence before construction in order to establish existing aquifer conditions. If deemed necessary a contingency action plan will be agreed with the Environment Agency, prior to the start of construction, with agreed actions in place if changes in water quality are observed. The objective of the plan will be to prevent any significant impacts occurring to the aquifer or the watercourse. Monitoring will then continue through the period of construction and into the post-construction period.

3.5.16 The discharge location for dewatering during construction of the vent shaft has not yet been determined, but it is currently assumed to be Tributary of River Mersey 2, that is the closest watercourse to the construction area. The dewatering discharge could lead to deterioration in water quality in the receiving watercourse. As with the aquifer, the risk of an impact on surface water quality is considered to be low. The proposed methodology of full depth diaphragm walls reduces the risk of saline water contaminating dewatering discharge and the application of the draft CoCP will manage the quality of discharge to Tributary of River Mersey 2 (also known as Fielden Park Brook). As such, the impact on water quality is assessed as negligible, leading to a negligible effect which is not significant on the moderate value watercourse. No impact is expected on the quality and substantial flow in the downstream River Mersey.

3.5.17 Borehole at Didsbury Golf Club, Northenden, Wythenshawe (abstraction licence 2569015006) is located approximately 500m south-east of the Palatine Road vent shaft. The borehole abstraction is from the Wilmslow Sandstone Formation Principal aquifer. The proposed construction methodology (full depth diaphragm walls) for the shaft reduces the impact of dewatering during the construction of the vent shaft on this abstraction and groundwater levels in the borehole at Didsbury Golf Club are unlikely to be impacted. As such, the temporary impact on this borehole is assessed to be negligible, leading to a negligible effect, which is not significant. If further investigation by the nominated undertaker shows there is a potential risk to the supply this will be discussed with the licence owner concerned, with a view to providing the necessary mitigation to ensure there will be no significant effect. Examples of mitigation options may include providing a temporary water supply or deepening of the borehole.

3.5.18 Palatine Road vent shaft will be located within the area of allocation MA07/299[4]. While there is potential for temporary, localised effects on groundwater level and flow during dewatering, this is unlikely to significantly affect allocation MA07/299.

3.5.19 Internal dewatering at the vent shaft may result in some short-term, localised effects on the baseflow in the Tributary of River Mersey 2 (also known as Fielden Park Brook) that is located approximately 130m from the vent shaft. The majority of the catchment for this tributary is located upgradient of the shaft and the proposed construction method will reduce the radius of influence, leading to a negligible effect which is not significant on the moderate value watercourse.

3.5.20 The impact on potentially groundwater dependent receptors in the area, including River Mersey, Tributary of River Mersey 1 and 3, as well as the potentially groundwater dependent habitats Stenner Woods and Milgate Fields, Didsbury and Fletcher Moss LNR and SBI and Wrengate Wood & Heyscroft SBI and Ancient Woodland, will be negligible. The flow in the River Mersey is too large to be affected and the two tributaries

and other sites are a substantial distance from the vent shaft or on the opposite side of the River Mersey from the vent shaft. Wrengate Wood & Heyscroft SBI and Ancient Woodland is approximately 300m from the vent shaft but is on the opposite bank of Tributary of River Mersey 2 to the shaft. Any impact on water features in the area would not be expected to extend beyond the tributary.

Wilmslow Road vent shaft

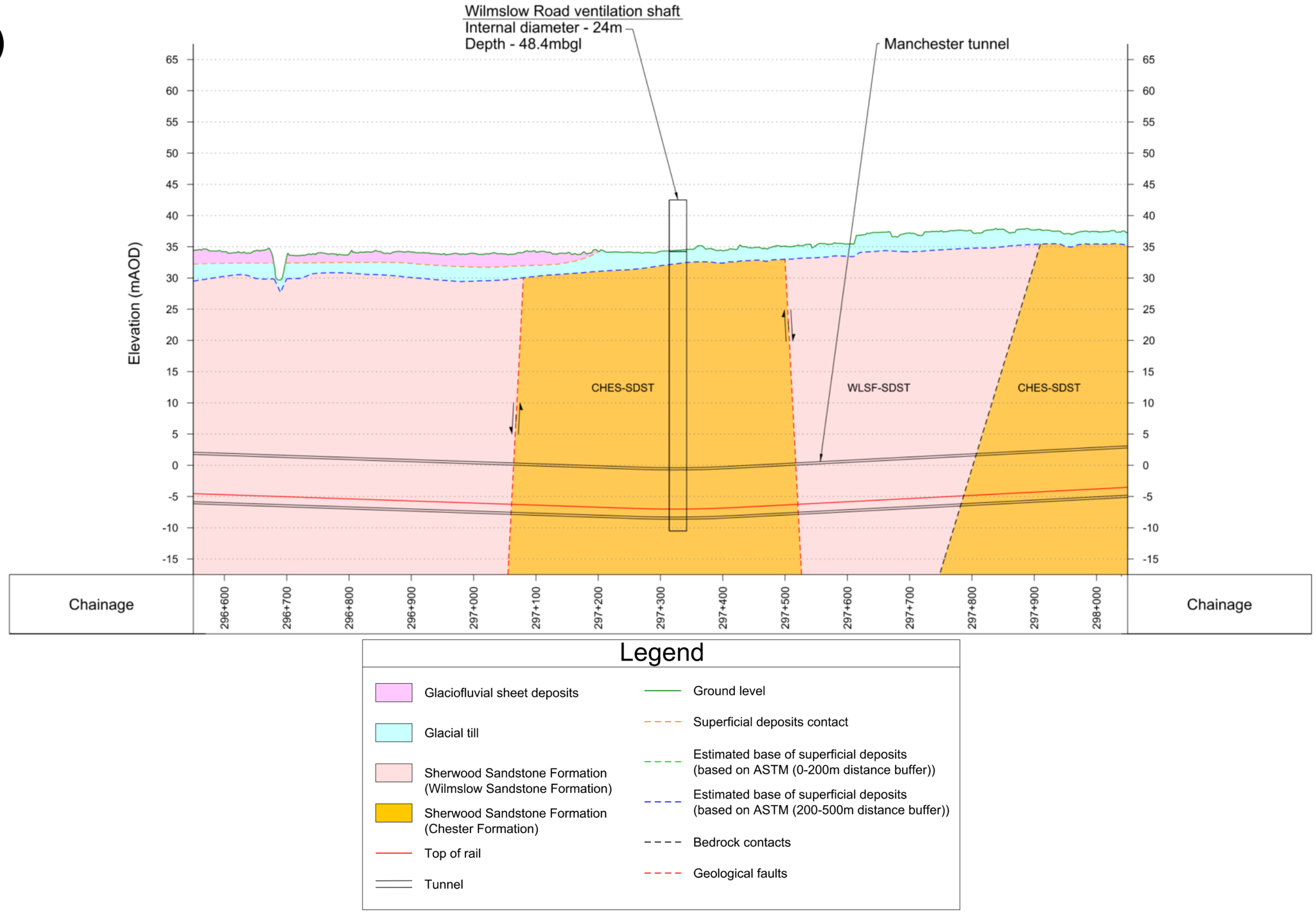
Table 8: Summary of the parameters for the groundwater assessment of Wilmslow Road vent shaft

Vent shaft parameters	Parameter details
Diameter (m)	24
Maximum depth (m)	48.4
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Sherwood Sandstone Group (Chester Formation) (Principal aquifer)
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Glaciofluvial sheet deposits (Secondary A aquifer) Shirdley Hill Sand Formation (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Sherwood Sandstone Group (Wilmslow Sandstone Formation) (Principal aquifer) Sherwood Sandstone Group (Chester Formation) (Principal aquifer) Allocation MA07/299[4]

3.5.21 The vent shaft will penetrate the glacial till Secondary (Undifferentiated) aquifer and the top of the Sherwood Sandstone Group (Principal) aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area for the glacial till and the Sherwood Sandstone Group. It has therefore been conservatively assumed that groundwater levels are at ground level and that groundwater flow within the glacial till and the Sherwood Sandstone Group may be affected by the vent shaft dewatering. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.5.22 The construction methodology of the vent shaft assumes that external dewatering is not permitted. As such, the construction methodology will include secant piled walls through the superficial deposits followed by the excavation and spray concrete lining of the section through the Sherwood Sandstone bedrock. The SCL will also be installed progressively as excavation advances, as such seepage pathways would be progressively sealed in a staged and sequentially controlled process during construction. If and when required, injection grouting and ejector wells will be implemented to control the inflow of water into the excavation. A schematic geological cross section of the Wilmslow Road vent shaft is provided in Figure 3.

Figure 3: Geological cross section of the Wilmslow Road vent shaft



Adapted from Crewe to Manchester MA07/M003 Geotechnical Plan and Profile Chainage drawing (2DE01-MWJ-GT-DGA-M003-360007). Scale H: 1:10,000, V: 1:1000. ASTM - American Society for Testing and Materials

3.5.23 The construction methodology means only internal temporary dewatering, using ejector wells or similar, will be required. Dewatering of the bedrock aquifer may, however, lead to a reduction or reversal in upward leakage from the bedrock to the overlying aquifer in the glacial till in the area around the shaft, if the current groundwater level in the bedrock aquifer is above the groundwater level in the superficial deposits. If the groundwater level in the bedrock aquifer is below the groundwater level in the superficial deposits, the dewatering could produce an increase in leakage from the glacial till, or the glaciofluvial sheet deposits nearby, to the bedrock. In either case, the groundwater level in the superficial deposits could be reduced locally as a result of the dewatering. However, taking into account the widespread extent of the glacial till and glaciofluvial sheet deposits in the area, the impact on groundwater levels and flow in the superficial deposits will be negligible, resulting in a negligible effect which is not significant.

3.5.24 The vent shaft will penetrate to the base of the glacial till and extend into the underlying Sherwood Sandstone Group bedrock. The proposed methodology will limit the zone of drawdown from dewatering during construction. The temporary impact of dewatering on groundwater flow in the bedrock should be short-term, as the SCL will be applied progressively throughout excavation. Overall, the temporary impact of the vent shaft construction on groundwater flow is likely to be minor on the Sherwood Sandstone Group as a whole, leading to a moderate effect which is significant.

3.5.25 As indicated in the Water resources assessment baseline data (BID WR-004-0MA07) and discussed for the Palatine Road vent shaft, up-coning of saline groundwater in the Sherwood Sandstone Group aquifer has occurred in the Trafford Park area, located approximately 6.3km north-west of the Wilmslow Road vent shaft, as a result of high levels of groundwater abstraction from deep boreholes over many years. There is no evidence of up-coning of saline groundwater present at depth in the Sherwood Sandstone Group in the vicinity of the Manchester tunnel. The shaft is relatively shallow in comparison with the affected boreholes in Trafford Park, and the rates of dewatering are likely to be low during the period of construction of the shaft section in the aquifer. However, the temporary dewatering for the construction of the vent shaft could potentially cause upwelling of saline water, if present towards the base of the Sherwood Sandstone Group aquifer in this area. However, the saline boundary is estimated to be located greater than 100m deep[9] whereas the vent shaft extends to a maximum depth of 48.4m so is unlikely to encounter poor quality water. Additionally, inflows rates have been estimated between 2l/s and 43l/s across various permeabilities (from 1x10-6m/s to 1x10-4m/s) under transient conditions over a period of 95 days. The range in permeability accounts for the difference in permeability across the sandstone formation (faults and the bedrock geology). As such, it is unlikely that saline upwelling will occur, during this short time period and with low dewatering rates. Taking into account the proposed methodology (no allowance for external dewatering), the shallow depth compared to the saline boundary and the limited period of dewatering, the risk of impact on the aquifer is considered low. This is assessed as a negligible impact on groundwater water quality in the high value Sherwood Sandstone in the area, leading to a negligible effect which is not significant.

3.5.26 Poor quality groundwater might also be drawn into the Sherwood Sandstone aquifer along fault boundaries from underlying formations such as the Collyhurst Sandstone and Coal Measures, or from near surface (anthropogenically contaminated) water during dewatering. Therefore, the temporary dewatering for vent shaft construction could potentially lead to a permanent impact on the water quality in the Sherwood Sandstone Group aquifer. Taking into account the proposed methodology (no allowance for external dewatering), relative shallow depth and location of the shaft within the Sherwood Sandstone Group aquifer, together with the information on inflow rates presented above, the risk of an impact on the aquifer is considered to be low. As such, it is assessed to be a negligible impact on groundwater quality in the high value Sherwood Sandstone in the area, leading to a negligible effect which is not significant.

3.5.27 It should be noted that this assessment is based on understanding from BGS hydrogeology and geology and there remains uncertainty regarding fracturing, faulting and how groundwater flows between these fault blocks i.e. whether there are high permeability groundwater flow pathways. As with the Palatine Road vent shaft, a detailed exploratory borehole investigation and groundwater monitoring programme will be undertaken in the area around the vent shaft site, prior to detailed design. The details of this programme, that may also include test pumping of boreholes to provide data to improve the assessment of the zone of influence, will be agreed in advance with the Environment Agency. The results of the investigation will focus on improving groundwater flow in the area and be used to refine this assessment and review the shaft dewatering proposals. Regular monitoring of groundwater levels and groundwater quality around the vent shaft site, and at levels in the aquifer below the depth of the vent shaft, will commence before construction in order to establish existing aquifer conditions. If deemed necessary a contingency action plan will be agreed with the Environment Agency, prior to the start of construction, with agreed actions in place if changes in water quality are observed. The objective of the plan will be to prevent any significant impacts occurring to the aquifer. Monitoring will then continue through the period of construction and into the post-construction period. It is also acknowledged that there could be voids in the Manchester area that have been historically used for water storage. A methodology and contingency plan will be developed in the instance that voids are identified during investigation or construction.

3.5.28 The discharge location for dewatering during construction of the vent shaft has not yet been determined, and there are no surface watercourses in the vicinity of the shaft. Therefore, it is assumed that dewatering discharge is likely to be to sewer. If early ground investigations indicate a significant quantity of discharge from the dewatering works, the additional demand on the local sewer network will be discussed with the water company.

3.5.29 Wilmslow Road vent shaft will be located within the area of allocation MA07/299[4]. While there is potential for temporary, localised effects on groundwater level and flow during dewatering, this is unlikely to significantly affect allocation MA07/299.

[9] Depth of saline boundary estimated from boreholes in the Manchester and East Cheshire area from Griffiths, K J, Shand, P and Ingram J, (2003), Baseline Report Series: 8. *The Permo-Triassic Sandstones of Manchester and East Cheshire*. British Geological Survey Commissioned Report No. CR/03/265N.

Birchfields Road vent shaft

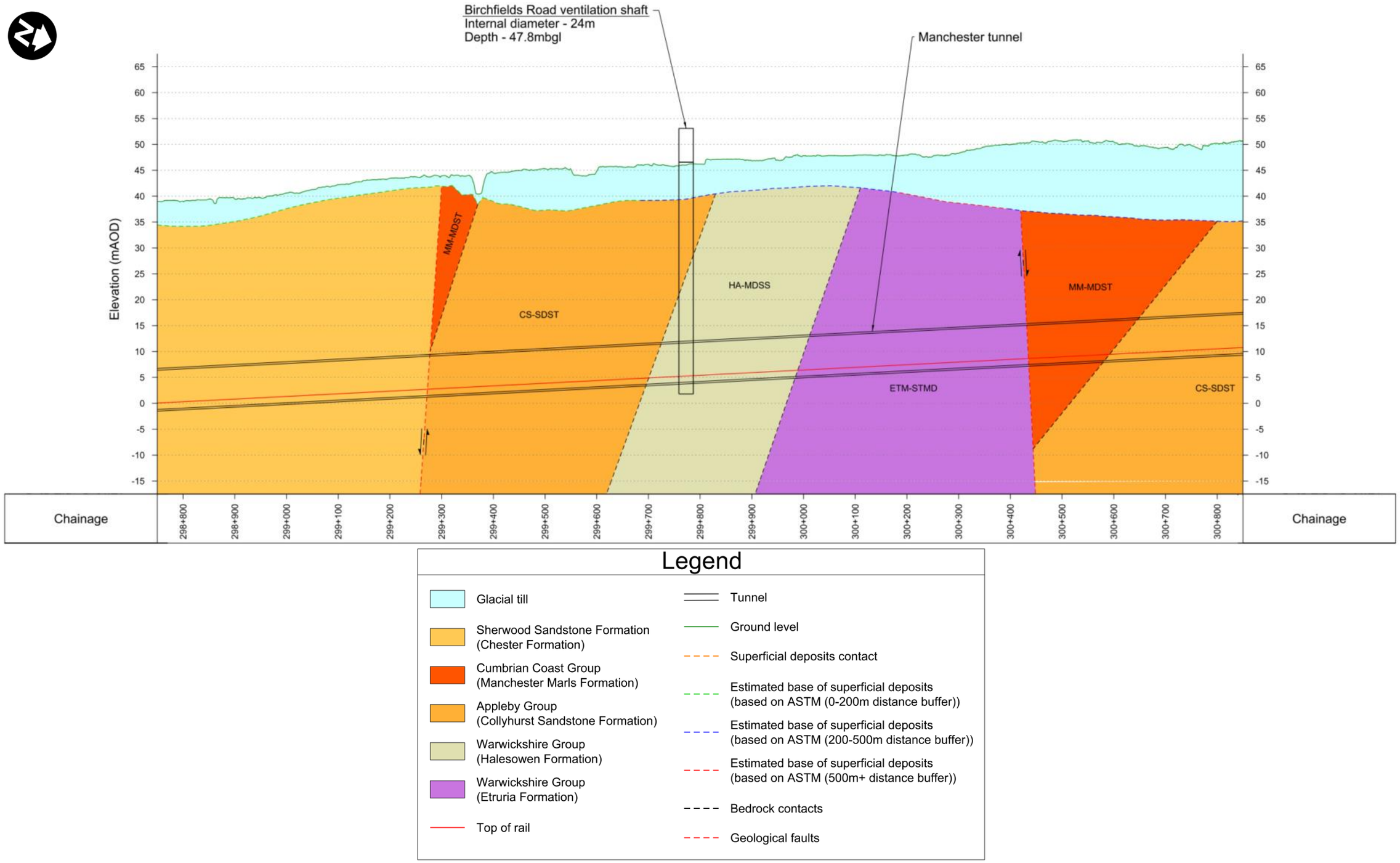
Table 9: Summary of the parameters for the groundwater assessment of Birchfields Road vent shaft

Vent shaft parameters	Parameter details
Diameter (m)	24
Maximum depth (m)	47.8
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Appleby Group (Collyhurst Sandstone Formation) (Principal aquifer) Warwickshire Group – Halesowen Formation (Secondary A aquifer)
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Glaciofluvial ice contact deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Sherwood Sandstone Group (Chester Formation) (Principal aquifer) Cumbrian Coast Group (Manchester Marls Formation) (Secondary B aquifer) Appleby Group (Collyhurst Sandstone Formation) (Principal aquifer) Warwickshire Group (Halesowen Formation) (Secondary A aquifer) Warwickshire Group (Etruria Formation) (Secondary A aquifer) Tributary of Cringle Brook 1 Cringle Brook Fallowfield Brook Tributary of Platt Brook 1 Gore Brook Allocation MA07/299[4]

3.5.30 The vent shaft will penetrate the glacial till Secondary (Undifferentiated) aquifer and the top of the Appleby Group (Principal) and Warwickshire Group (Secondary A) aquifers. There is no currently available information on groundwater elevations or depth to groundwater in this area for the glacial till and the Appleby Group. It has therefore been conservatively assumed that groundwater levels are at ground level and that groundwater flow within the glacial till and the Appleby Group may be affected by the vent shaft dewatering. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.5.31 The construction methodology of the vent shaft assumes that external dewatering is not permitted. As such, the construction methodology will include secant piled walls through the superficial deposits followed by the excavation and spray concrete lining of the section through the Appleby and Warwickshire Groups. The SCL will also be installed progressively as excavation advances, as such seepage pathways would be progressively sealed in a staged and sequentially controlled process during construction. If and when required, injection grouting and ejector wells will be implemented to control the inflow of water into the excavation. A schematic geological cross section of the Birchfields Road vent shaft is provided in Figure 4.

Figure 4: Geological cross section of the Birchfields Road vent shaft



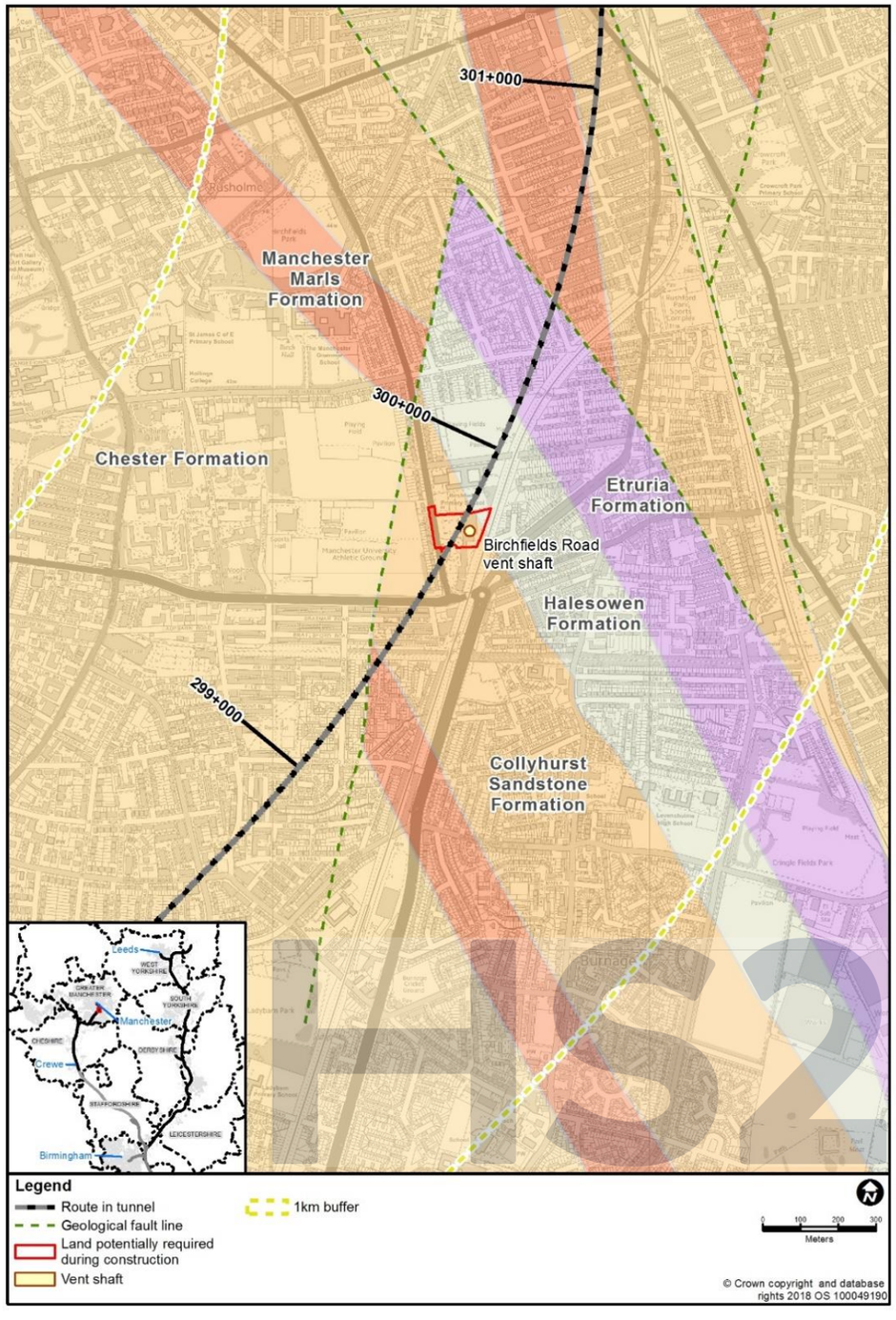
Adapted from Crewe to Manchester MA07/M003 Geotechnical Plan and Profile Chainage drawing (2DE01-MWJ-GT-DGA-M003-360008). Scale H: 1:10,000, V: 1:1000. ASTM - American Society for Testing and Materials

3.5.32 The construction methodology means only internal temporary dewatering, using ejector wells or similar, will be required. Dewatering of the bedrock aquifer may, however, lead to a reduction or reversal in upward leakage from the bedrock to the overlying aquifer in the glacial till in the area around the shaft, if the current groundwater level in the bedrock aquifer is above the groundwater level in the superficial deposits. If the groundwater level in the bedrock aquifer is below the groundwater level in the superficial deposits, the dewatering could produce an increase in leakage from the glacial till, or the glaciofluvial sheet deposits nearby, to the bedrock. In either case, the groundwater level in the superficial deposits could be reduced locally as a result of the dewatering. However, taking into account the widespread extent of the glacial till and glaciofluvial sheet deposits in the area, the impact on groundwater levels and flow in the superficial deposits will be negligible, resulting in a negligible effect, which is not significant. The nearest watercourses to the vent shaft, Fallowfield Brook, Cringle Brook, Gore Brook, Tributary of Cringle Brook 1 and Tributary of Platt Brook 1, are in fully or partially in culvert in proximity to the vent shaft and should not, therefore, be affected significantly by the dewatering impacts on the glacial till.

3.5.33 The vent shaft will penetrate the base of the glacial till and extend into the underlying bedrock. The bedrock in this area is heavily faulted and as such the shaft will be constructed in a sub-crop of the Collyhurst Sandstone Formation and underlying Halesowen Formation, with Manchester Marls Formation to the south, Chester Formation to the west and Etruria Formation to the north as shown in Figure 5. The Environment Agency regional groundwater conceptual model report 2004[10] suggests that the faults in this area restrict groundwater flow. The report suggests that the faults to the west and north of the shaft site hydraulically separate the Collyhurst Sandstone Formation, Halesowen and Etruria Formation block where the shaft is located from the Sherwood Sandstone Group and Appleby Group to the west and north. In addition, the Manchester Marls Formation restricts groundwater flow from the south. Therefore, the temporary impact of dewatering at this shaft site is likely to be limited to the isolated block of the Collyhurst Sandstone Formation Principal aquifer, the Halesowen Formation Secondary A aquifer and the Etruria Formation Secondary A aquifer. The temporary impact of dewatering on groundwater levels and flow in the bedrock is assessed to be moderate on the limited area of sub-crop for the Collyhurst Sandstone Formation and underlying Halesowen Formation, leading to a moderate effect, which is significant for both aquifers. The impact on the Etruria Formation is assessed to be minor leading to minor effect, which is not significant. As the construction technique of the shaft will reduce dewatering requirements using a staged and sequentially controlled process, together with ground treatment as considered necessary, and the aquifers are expected to recover quickly from the impact of dewatering, the permanent effect of the vent shaft on groundwater level and flow in the Collyhurst Sandstone Formation, Halesowen Formation and Etruria Formation is assessed to be negligible, leading to a negligible effect which is not significant.

[10] ESI (April 2004), *Manchester and East Cheshire Water Resources Study: Final Report*. *6184a R3.* Appendix C.

Figure 5: Geology around Birchfields Road vent shaft



3.5.34 The temporary lowering of groundwater levels during dewatering for the construction of the vent shaft could potentially draw poorer quality groundwater into the Collyhurst Sandstone Formation and Halesowen Formation aquifers from the adjacent Etruria Formation or underlying Coal Measures. Therefore, the temporary dewatering for vent shaft construction could potentially lead to a permanent impact on the water quality in the Appleby Group and the Warwickshire Group aquifers. However, inflows rates have been estimated between 2l/s and 43l/s across various permeabilities (from $1x10^{-6}$m/s to $1x10^{-4}$m/s) under transient conditions over a period of 95 days. The range in permeability accounts for the difference in permeability across the sandstone formations (faults and the bedrock geology). As such, it is unlikely that saline upwelling will occur, during this short time period and with low dewatering rates. Taking into account the proposed methodology (internal temporary dewatering only) and the limited period of dewatering, the risk of impact on the aquifer is considered low. This is assessed as a negligible impact on groundwater water quality in the high value Appleby Group and moderate value Halesowen Formation in the area, leading to a negligible effect which is not significant.

3.5.35 The discharge location for dewatering during construction of the vent shaft has not been determined but is likely to be to sewer as there are no watercourses within the vicinity of the shaft, therefore no impacts on surface water quality are expected. If early ground investigations indicate a significant quantity of discharge from the dewatering works, the additional demand on the local sewer network will be discussed with the water company.

3.5.36 Birchfields Road vent shaft will be located within the area of the allocation MA07/299[4]. While there is potential for temporary, localised effects on groundwater level and flow during dewatering, this is unlikely to significantly affect allocation MA07/299.

3.5.37 It should be noted that this assessment is based on understanding from BGS hydrogeology and geology and there remains uncertainty regarding fracturing, faulting and how groundwater flows between these fault blocks i.e. whether there are high permeability groundwater flow pathways. As with the Palatine Road vent shaft, a detailed exploratory borehole investigation and groundwater monitoring programme will be undertaken in the area around the vent shaft site, prior to detailed design. The details of this programme, that may also include test pumping of boreholes to provide data to improve the assessment of the zone of influence, will be agreed in advance with the Environment Agency. The results of the investigation will focus on improving groundwater flow in the area and be used to refine this assessment and review the shaft dewatering proposals. Regular monitoring of groundwater levels and groundwater quality around the vent shaft site, and at levels in the aquifer below the depth of the vent shaft, will commence before construction in order to establish existing aquifer conditions. If deemed necessary a contingency action plan will be agreed with the Environment Agency, prior to the start of construction, with agreed actions in place if changes in water quality are observed. The objective of the plan will be to prevent any significant impacts occurring to the aquifer. Monitoring will then continue through the period of construction and into the post-construction period. It is also acknowledged that there could be voids in the Manchester area that are often used for water storage. A methodology and contingency will be developed in the instance that voids are identified during investigation or construction.

3.6 Impacts to groundwater quality from viaduct and overbridge piling

3.6.1 There are no viaducts or overbridges within the Davenport Green to Ardwick area.

3.7 Impacts to groundwater from borrow pits

3.7.1 There are no borrow pits within the Davenport Green to Ardwick area.

4 Site specific water dependent habitats assessment

4.1 Summary of assessment

4.1.1 Table 10 summarises the potential hydrological impacts (for example, changes to flow, level, regime, or quality) related to groundwater dependent habitats. Further details of the ecology of these sites and the assessment of the local level ecological effects arising from water impacts, are provided in the Ecological register of local level effects, Volume 5, Appendix EC-015-0MA07. Where there are significant effects, the ecological effects and associated mitigation are reported in Volume 2, Community Area report: Davenport Green to Ardwick (MA07), Section 7, Ecology and biodiversity.

Table 10: Summary of potential water dependent habitat impacts

Receptor	Design element	Discussion of potential impact to water receptor
Groundwater dependent habitats		
Blackcarr Wood and Baguley Bottoms SBI	Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft	It is currently unclear if this site is supported by groundwater but it has been included on a precautionary basis. Blackcarr Wood and Baguley Bottoms is partially within the radius of influence of the Altrincham Road vent shaft. As a result of the construction methodology applied through the superficial deposits, the potential impact of shaft dewatering on the site and on groundwater discharge to the water dependent habitat is assessed as minor (see Section 3.2).
Wythenshawe Park LNR and Gib Lane Wood SBI	Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft	Wythenshawe Park and Gib Lane Wood is a groundwater dependant habitat partially located within the radius of influence of the Altrincham Road vent shaft. As a result of the construction methodology applied through the superficial deposits, the impact of dewatering on the site and on groundwater discharge to the water dependent habitat is assessed as negligible.
Round Wood SBI and ancient woodland	Deeper excavations (>1mbgl) including: • Altrincham Road vent shaft	It is currently unclear if this site is supported by groundwater but it has been included on a precautionary basis. The habitat is located within the radius of influence of the Altrincham Road vent shaft. As a result of the construction methodology applied through the superficial deposits, the impact of dewatering on the site and on groundwater discharge to the water dependent habitat is assessed as negligible.
Rose Hill Woods SBI	None	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The Proposed Scheme is unlikely to alter groundwater quality or flow to this site since it is located outside of the radius of influence of vent shafts and cuttings in the area and is located upgradient of the Proposed Scheme.
Stenner Woods and Milgate Fields LNR, Fletchers Moss SBI	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; and • temporary works such as stockpiles and compounds. Deeper excavations (>1mbgl) including: • Palatine Road vent shaft	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. Stenner Woods and Milgate Fields, Fletchers Moss is 40m south-east of land required for the construction of the Proposed Scheme. As such, there is potential for temporary impacts on groundwater quality during the construction phase. This will be managed through implementation of the draft CoCP. The habitat is partially within the radius of influence of the Palatine Road vent shaft. However, as a result of the construction methodology applied through the superficial deposits, the impact of shaft dewatering on the site and on groundwater discharge to the water dependent habitat is assessed as negligible.
Wrengate Wood SBI and ancient woodland	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; and • temporary works such as stockpiles and compounds Deeper excavations (>1mbgl) including: • Palatine Road vent shaft	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. Wrengate Wood is within the land required for the construction of the Proposed Scheme. As such, there is potential for temporary impacts on groundwater quality during the construction phase. This will be managed through implementation of the draft CoCP. The habitat is within the radius of influence of the Palatine Road vent shaft. However, as a result of the construction methodology applied through the superficial deposits, the impact of shaft dewatering on the site and on groundwater discharge to the water dependent habitat is assessed as negligible.

5 Site specific highways drainage assessments

5.1 Introduction

5.1.1 Roads are designed to drain freely to prevent the build-up of standing water on the carriageway whilst avoiding exposure to or causing flooding. Contaminants deposited on the road surface are quickly washed off during rainfall. Where traffic levels are high, the level of contamination increases and therefore the potential for unacceptable harm being caused to the receiving water also increases. There are many circumstances in that runoff from roads is likely to have no discernible effect, however a precautionary and best practice approach indicates the need for the assessment of the possible impact of pollutant discharges on the water environment from roads affected by the Proposed Scheme. These effects can either be through spillage and routine runoff pollution from new roads that are used during the construction and operational phases or changes in traffic movements on the existing road network.

5.1.2 The Proposed Scheme makes provision for two methods for draining new sections of highway: direct runoff to soakaway and drainage via an attenuation pond to an existing watercourse. Where changes in traffic volumes have been identified along the existing road network, steps have been taken to identify the type of drainage in place and an assessment has been made of whether the highway works proposed have implications for pollution risk within the Davenport Green to Ardwick area.

5.2 Methodology and assessment criteria

Routine runoff pollution risk

5.2.1 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 the Highways England Water Risk Assessment Tool (HEWRAT)[11]. Where highway realignments are to discharge to kerb side ditches that do not have a permanent baseflow, the Groundwater Assessment (Appendix C)[11] has been used.

5.2.2 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.

Spillage pollution risk

5.2.3 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 has been undertaken for highway realignments. The methodology for assessing spillage risk follows the Spillage Risk Assessment (Appendix D)[11].

5.3 Detailed assessment

Screening results

5.3.1 A screening exercise has not identified the need for a routine runoff assessment and pollution risk assessment or a spillage pollution risk assessment, in the Davenport Green to Ardwick area, during the construction or operational phases.

[11] Standards for Highways (2020), *Design Manual for Roads and Bridges* (*DMRB) – LA 113 Road Drainage and the Water Environment Revision 1*. Available online at: https://www.standardsforhighways.co.uk/prod/attachments/d6388f5f-2694-4986-ac46-b17b62c21727?inline=true.