

National Trust

Castlefield Viaduct, Manchester

Geotechnical and Geoenvironmental Desk Study

Reference: CVI-ARUP

P02 | 16 August 2024



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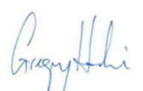
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Job number 282210-00

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Document Verification

Project title Castlefield Viaduct, Manchester
Document title Geotechnical and Geoenvironmental Desk Study
Job number 282210-00
Document ref CVI-ARUP
File reference 3-05

Revision	Date	Filename
P01		Description Prepared by Checked by Approved by Name Zaid Kotwal / Sam Cook Olly Carlton Justin Howell Signature
P02		Filename Description Issue to support planning application Prepared by Checked by Approved by Name Zaid Kotwal / Sam Cook Olly Carlton Greg Hardie Signature PP sign Olly Carlton   
		Filename Description Prepared by Checked by Approved by Name Signature

Issue Document Verification with Document ☐

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Executive Summary

Ove Arup and Partners Ltd (Arup) has been commissioned by the National Trust to undertake a Geotechnical and Geoenvironmental Desk Study for the proposed Castlefield Viaduct (the site).

Earliest available mapping shows a bridge crossing the River Medlock adjacent to the Bridgewater Canal and wharf. A lower level railway viaduct associated with Manchester South Junction and Altrincham Railway, was built by the late 1840s and the higher level railway viaduct (Castlefield Viaduct) was built by the early 1890s. Heavy industry including cotton mills and dye works is shown in the surrounding Castlefield area associated with the canal and railway links.

Heavy industry shown on available historical maps in the surrounding area includes, but not limited to chemical works, cotton and paper mills, iron works, engineering works and a variety of warehouses.

At ground level at the proposed lift shaft, ground conditions are expected to comprise made ground consisting of sandy clay, brick fragments and ash, over weathered sandstone encountered at approximately 8m below ground level. Groundwater is in continuity with the River Medlock, encountered at approximately 6m below ground level.

Due to the likely presence of compressible soils associated with the River Medlock, it is assumed that piled foundations will be required for the proposed lift shaft and staircase.

At the viaduct level, ballast and vegetation is present, with the ballast described as angular to subangular granite ballast with hydrocarbon staining. Groundwater is not present.

Based on Arup's knowledge of existing ground investigation (GI) on the viaduct, hand dug pits were excavated at ten locations across the viaduct to a maximum depth of 0.3m below ground level (mbgl). HP101 encountered a timber sleeper at 0.25mbgl whilst the rest of the hand dug pits reached the metal base of the viaduct. The general stratum found consisted of grass over dark brown sandy gravel with occasional rootlets. The gravel is fine to coarse, angular to subangular granite ballast with hydrocarbon staining.

Possible sources of contamination at the site include the ballast along the viaduct, flaking paint from the steel viaduct structure in the east of the site and made ground associated with historical development at ground level. The conceptual site model identified potential risks to construction workers, future site users, groundwater and building materials.

Intrusive investigation is required to establish the extent and nature of chemical contamination to inform risk assessments, geotechnical assessment and foundation design. The geotechnical and geoenvironmental risk register identifies mitigation measures to be implemented as part of the proposed scheme to address identified ground-related risks.

The site has been classified at moderate to high risk of Unexploded Ordnance (UXO) so mitigation measures will be needed during the intrusive GI and piling works. The culvert, existing railway viaducts and associated retaining walls are considered sensitive structures. Structural condition surveys are recommended to be undertaken prior to any construction works to assess if there is any existing damage.

1. Introduction

1.1 Commission and scope

Ove Arup and Partners Ltd (Arup) has been commissioned by the National Trust to undertake a Geotechnical and Geoenvironmental Desk Study to inform the Castlefield Viaduct development in Manchester.

The objective of the Geotechnical and Geoenvironmental Desk Study is to review available historical, geotechnical and geoenvironmental information relevant to the site and the nearby surrounding area and to highlight any potential ground related risks to the proposed development. The Desk Study informs the scope and preliminary design of an intrusive ground investigation and potential constraints relating to the ground investigation. This document will be submitted to the Manchester City Council to support the planning application.

1.2 Sources of information

The following sources of data and information have been reviewed as part of this desk study:

- British Geological Survey (BGS) geological mapping and adjacent borehole records available via the online GeoIndex viewer [1];
- BGS geological mapping, 1: 10, 560, Sheet SJ 89 NW, 1976 [2];
- BGS geological mapping, 1: 10, 560, Sheet SJ 89 NW, 2004 [3];
- BGS Superficial and Bedrock geology, Manchester Sheet 85, 1: 50, 000, 2011 [4];
- Department of Environment (DoE) Industry profiles (published in 1995) [5];
- National Library of Scotland (2023) Ordnance Survey Towns Plans of England and Wales / Scotland [6];
- Environment Agency Land Contamination: Risk Management [7];
- Royal Haskoning Phase 1 Surveys & Investigations - May 2021[8][9];

Details of the sources used are indicated in subsequent sections and are provided in the references section. Supporting information has been included in the appendices where appropriate.

1.3 Report structure

This report has the following structure:

- Section 2: Provides a description of the site in its current condition;
- Section 3: Documents the known site history and the geological and geoenvironmental setting;
- Section 4: Provides a summary of the key geoenvironmental constraints identified in relation to the proposed development;
- Section 5: Provides a summary of the key geotechnical constraints identified in relation to the proposed development;
- Section 6: Presents the geotechnical and geoenvironmental risk register; and
- Section 7: Presents conclusions of this assessment and recommendations for ground investigation.

1.4 Use and limitations of the report

This report was prepared by Arup on behalf of the National Trust (the Client) for Castlefield Viaduct, Manchester. It considers our client's instructions and requirements and addresses their priorities at the time.

This report is not intended for, and should not be relied on by any third party and no responsibility is undertaken to any third party in relation to it.

All reasonable skill, care and diligence have been exercised within the timescale available and in accordance with the technical requirements of the brief. Notwithstanding the efforts made by the professional team in preparing the report it is possible that other ground contamination or conditions as yet undetected may exist and consequently reliance on this report must be limited accordingly..

2. Site description

2.1 Site location and extent

The site is elevated on Castlefield viaduct approximately 150m south of Trinity Way; Egerton Street passes underneath the viaduct. The Bridgewater Canal is aligned parallel to the viaduct and connects to the River Irwell, which is situated approximately 200m to the west of the site. The site is bound to the north by Wilson Building and Potato Wharf, to the south by Bridgewater Canal and Egerton Street Bridge and to the west by commercial buildings and the River Irwell.

Castlefield Viaduct is a 330-metre long, grade II listed structure located within the Castlefield conservation area. The eastern 200m portion of viaduct comprises the National Trust public realm and gardens. Rail track has been removed on the remainder of the viaduct to the west and the surface contains railway ballast and other debris. There is currently only one point of entry from the Deansgate Tram Car Park, approximately 20 metres above ground level, which leads into an existing area of vegetation. To the south of the viaduct is the Metrolink line connecting Cornbrook to the west and Deansgate to the east.

The main structural elements of the viaduct are the longitudinal girders supporting the rails, spanning approximately 4m between transverse 'fish belly' girders. These fish belly beams extend transversely 11.5m to the lattice trusses' inner face, spanning the viaduct's full width. Deep lattice girders, measuring about 6m in height, span up to 53m between cast iron cylinders which are approximately 18m in height. These cylinders are filled with masonry for stability. Overhead bracing connects the tops of the lattice girders, while steel deck plates with waterproofing complete the structure, ensuring its durability and functionality.

The site is rectangular in shape covering an estimated 0.64ha and is centred on National Grid Reference SJ 82746 97482 as shown in Figure 1.



Figure 1: Site location

2.2 Topography

The topography of the site has been interpreted from Ordnance Survey Terrain 50 DTM data. The site is relatively flat and ranges between 24.5mOD to 27.5mOD, with the western section of the site ranging from 27.5mOD to 29mOD.

2.3 Utilities and drainage

A review of utility records for the area indicates utility corridors along Egerton Street. This includes electricity, gas, telecoms and sewer infrastructure running below the site and in areas adjacent to the site. For further information, refer to the latest available utility plans (*Castlefield Utilities – Combined.dwg [9]*).

2.4 Proposed development

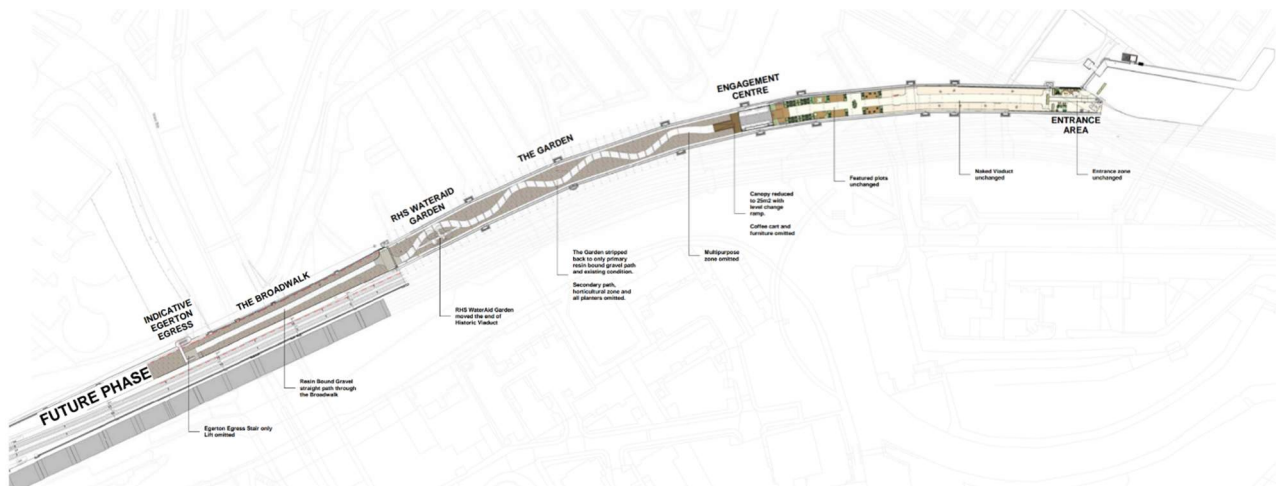


Figure 2: Indicative layout of proposed development

The proposed development at the site will comprise an urban park on the viaduct with garden areas and forms Phase 2 of the Castlefield Viaduct scheme. Ballast will be removed and will be replaced with either a topsoil or a mound with low cost and decorative grass, and a WaterAid Garden will also be installed. The steel spans which cross the viaduct at the east of the site will be remediated to remove and dispose any loose flaking paint. A new balustrade offset from the steel trusses will be installed as viaduct edge protection. There will be a resin bound gravel straight path through the Broadwalk and a lift shaft and staircase will be installed beneath the viaduct span to connect the urban park with the pavement on Egerton Street. The lift shaft and staircase are to be installed on piled foundations.

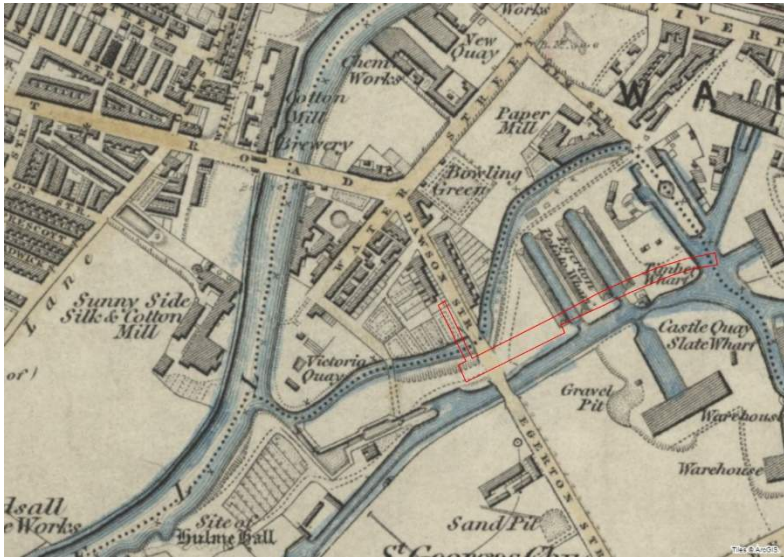
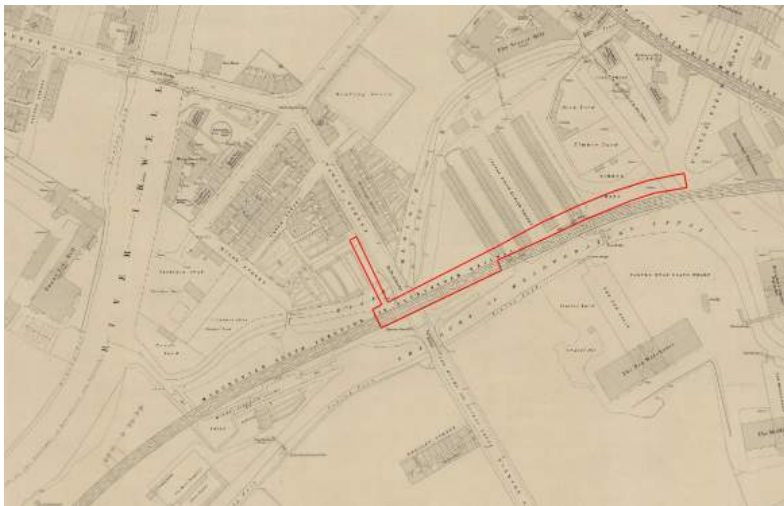
3. Site history and environmental setting

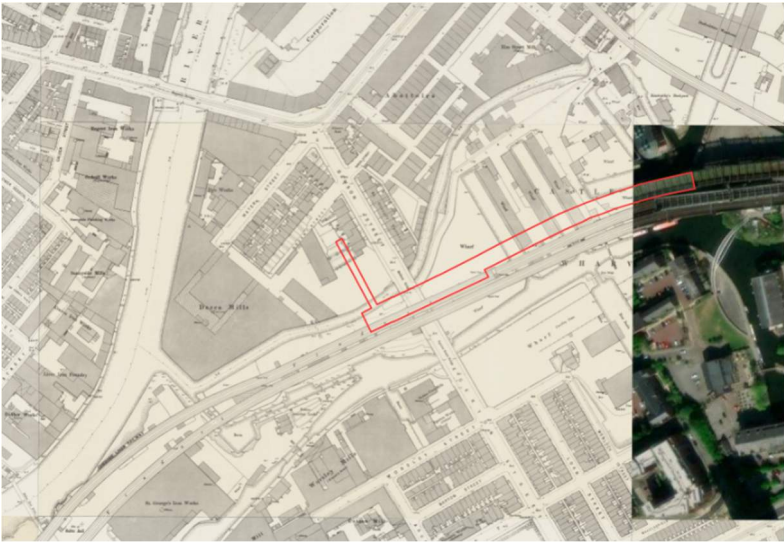
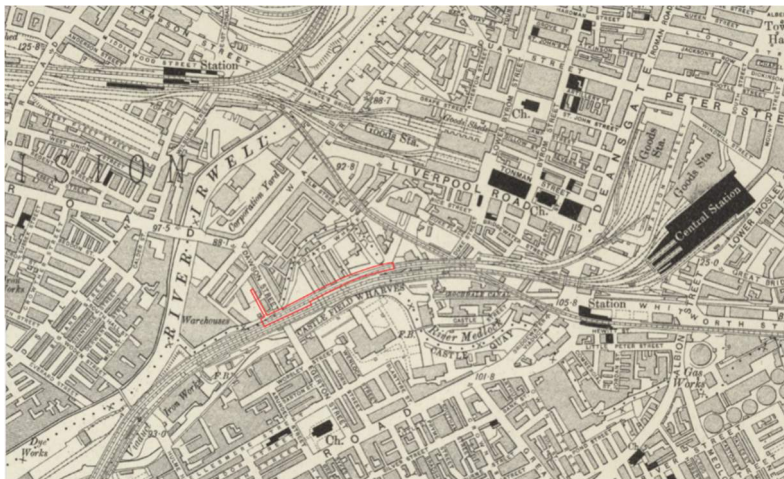
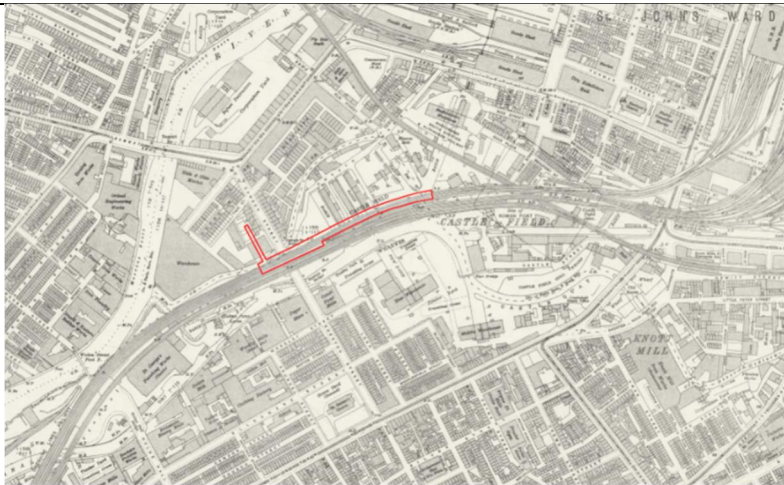
3.1 Site history

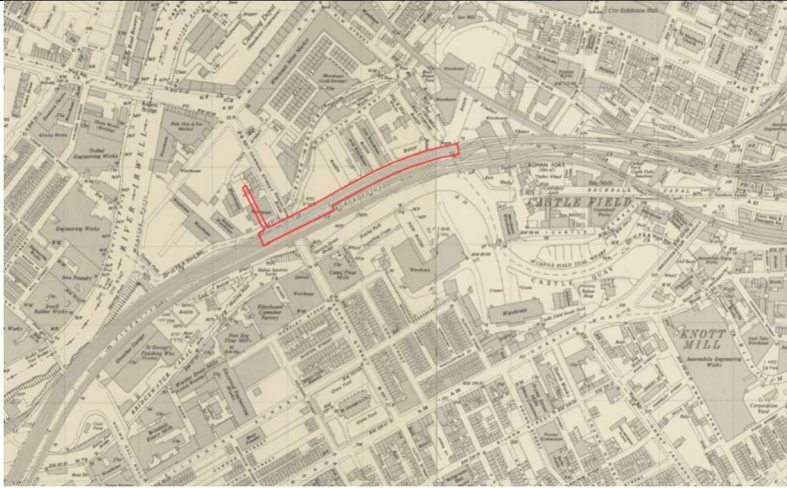
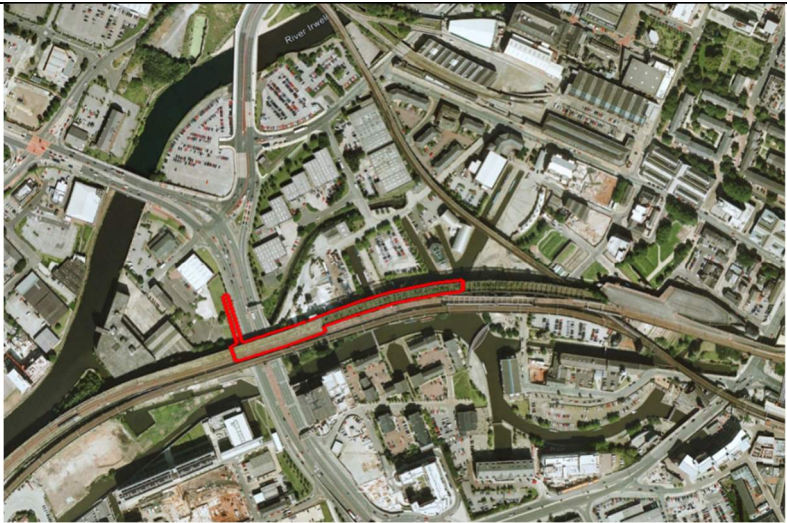
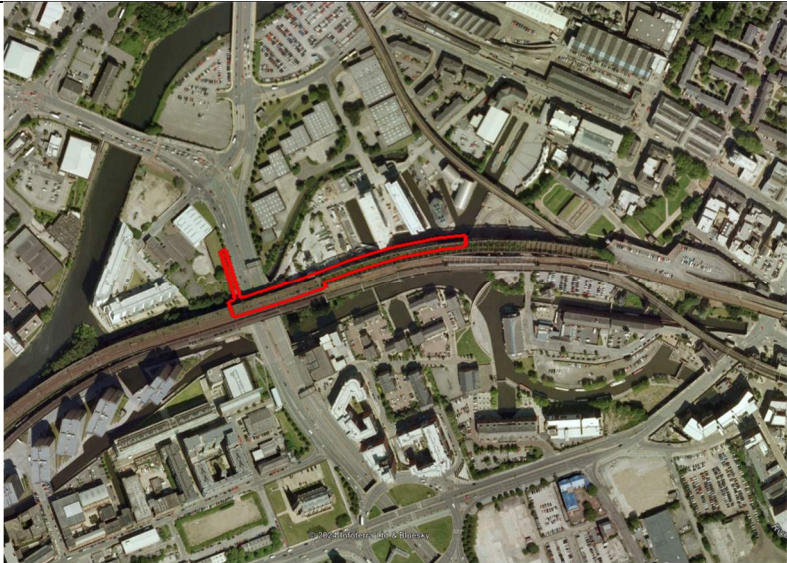
The history of the site has been summarised below based on historical mapping and aerial photography from Groundsure and Google Earth Pro. The following information has been reviewed:

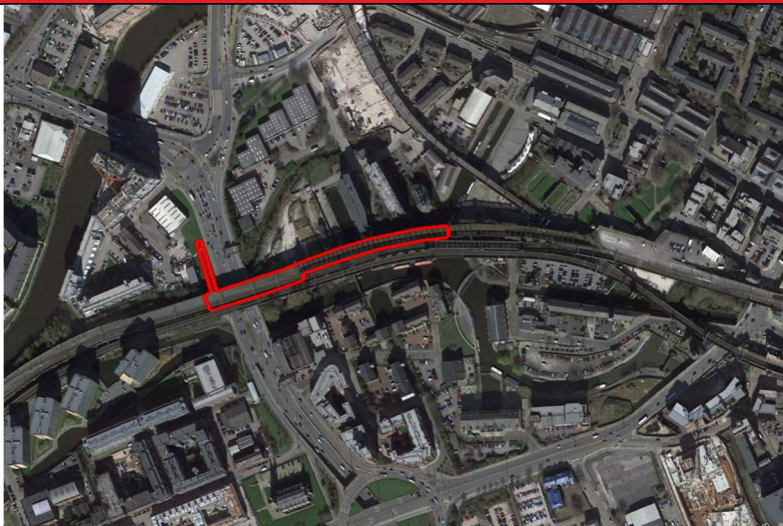
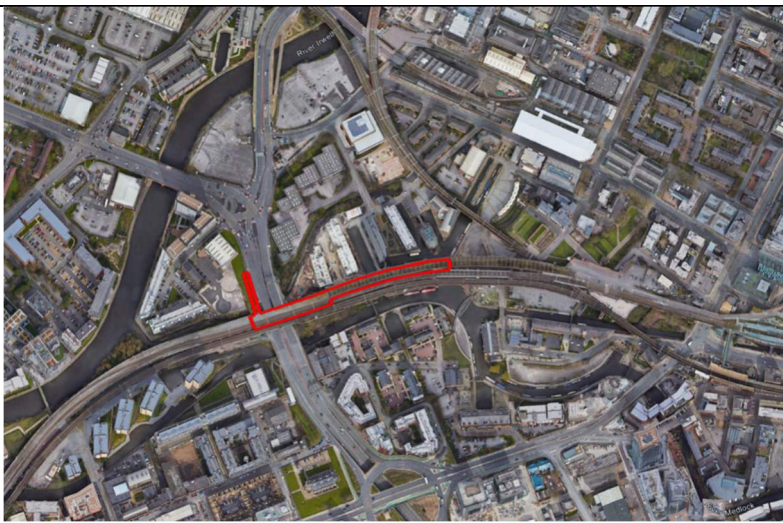
- National Library of Scotland Town Plans of England and Wales / Scotland [3];
- Google Earth imagery dating from 2003 to 2023;

Table 1: Summary of site history

Year	Map/aerial image extract	Observations
1848 National Library of Scotland		Dawson Street is present along the western edge of the site. Potato and Timber Wharfs, associated with the Bridgewater Canal are present in the east of the site. Surrounding the site is a gravel pit and heavy industry such as chemical works, silk, cotton and paper mills. A small number of residential houses are present off Dawson Street north of the site.
1851 National Library of Scotland Scale 1:2,640		A railway is shown immediately south of the Castlefield Viaduct. This railway viaduct, spanning Dawson Street, canal wharfs and Bridgewater Canal is associated with Manchester South Junction and Altrincham Railway. Present on the 1851 OS map, anecdotal information suggests construction was completed by late 1840s

Year	Map/aerial image extract	Observations
1895 National Library of Scotland Scale 1:500		The Castlefield Viaduct has been constructed. This railway viaduct is built at a slightly higher level, also spans Dawson Street, canal wharfs and Bridgewater Canal. Present on the 1895 OS map, anecdotal information suggests construction was completed by late 1892. More heavy industry (cotton mills and dye works) is shown 100m east of the site and slaughterhouses are shown 150m north of the site.
1909 National Library of Scotland		Warehouses occupy the Victoria Wharf area 50m west of the site. South of the canal, opposite the site are residential areas. Iron works are present 250m southwest of the site, on the opposite side of Bridgewater Canal. Manchester Central Station is shown in the east of the map is the end terminus of the railway line that uses the Castlefield Viaduct.
1922 National Library of Scotland		Potato wharf is occupied by basins. The corporation yard 250m north of the site has refuse destructors and there is a commercial hotel 250m northeast of the site. Opposite the Bridgewater Canal a towing path with travelling cranes, flour mills and a warehouse are shown.

Year	Map/aerial image extract	Observations
1944-73 National Library of Scotland Scale 1:2,500		There are acid warehouses directly northeast of the site with various warehouses to the northwest of the site also, including a bonded warehouse. There are an increased number of works and warehouses, including engineering works, a fireboard container factory, cotton weaving mills, textiles works and a brass foundry.
2003 Google Earth Imagery		The railway on Castlefield Viaduct and associated sidings are no longer shown. The railway ceased operations in the late 1960's with the closure of Manchester Central station located to the east of the viaduct. Dawson Street and Egerton Street are shown as part of the Manchester Ring Road. 100m north of the site are multistorey car parks, ground level car parks and industrial buildings. Warehouses in the Potato Wharf have been demolished are there are now street car parks.
2009 Google Earth Imagery		No significant changes within the red line boundary. The Vie building is constructed to the east of the site. There are residential buildings 50m east of the site.

Year	Map/aerial image extract	Observations
2017 Google Earth Imagery		No significant changes within the red line boundary. Construction work taking place for the One Regent apartment building approximately 150m northwest and a multistorey car park has been levelled 175m northeast of the site. Land 10m north of the site has been cleared.
2020 Google Earth Imagery		No significant changes within the red line boundary. Construction work taking place for the Wilson apartment building directly north of the site. 200m north of the site, a Self Storage and industrial Centre has been built.
2023-current Google Earth Imagery		No significant changes within the red line boundary. The ground level car parks located 200m north of the site have been cleared and construction is shown.
¹ Reproduced with the permission of the National Library of Scotland		

3.2 Geology

The following sources of information have been reviewed:

- British Geological Survey (BGS) geological mapping and adjacent borehole records available via the online GeoIndex viewer [1];
- BGS geological mapping, 1: 10, 560, Sheet SJ 89 NW, 1976 [2];
- BGS geological mapping, 1: 10, 560, Sheet SJ 89 NW, 2004 [3];
- BGS Superficial and Bedrock geology, Manchester Sheet 85, 1: 50, 000, 2011 [4];

3.2.1 Made ground

No made ground is shown on the geological map. Made ground is anticipated to be present at ground level from previous site development where the lift shaft and staircase will be installed.

3.2.2 Superficial deposits

The British Geological Survey (BGS) 1:10,560 map Sheet SJ 89 NW (2004) indicates Alluvium, glaciofluvial sheet deposits and glacial till are present with the area surrounding the site, but no superficial deposits are shown on the site itself.

3.2.3 Solid geology

Bedrock at the Site is sandstone of the Chester Pebble Beds Formation of the Sherwood Sandstone Group.

3.3 Historical ground investigation data

3.3.1 BGS borehole records

The British Geological Survey (BGS) online borehole database provides access to scans of borehole logs for previous ground investigations across the UK. A search has been carried out to access historical boreholes closest to the site.

Table 2: Nearby BGS borehole records.

Borehole ID	Location	Year	Comment
SJ89NW1297	<10m north	1991	Located west of Egerton Street below Castlefield Viaduct. Made ground (8.2m thick) over very weathered sandstone encountered approximately 8mbgl and proven to a depth of 10mbgl. Made ground described as brick and ash fill with iron foundry furnace slag recorded between 5.2 and 7.5 mbgl.
SJ89NW1980	<10m west	1991	Located centre of Egerton Street adjacent to Castlefield Viaduct. Made ground recorded as ash fill (2.4m thick) over very soft alluvial clays and loose sands (7.7m thick). Very weathered sandstone encountered approximately 10mbgl and proven to a depth of 16.7mbgl.
SJ89NW1300	25m south	1992	Borehole conducted adjacent to road bridge off a scaffolding platform. Made ground (6.5m thick) over alluvium (1.5m thick) over weathered sandstone encountered at approximately 8mbgl, proven to a depth of 20mbgl. Made ground described as clay with brick, concrete, coal and sandstone fragments.

3.3.2 Existing Ground investigation

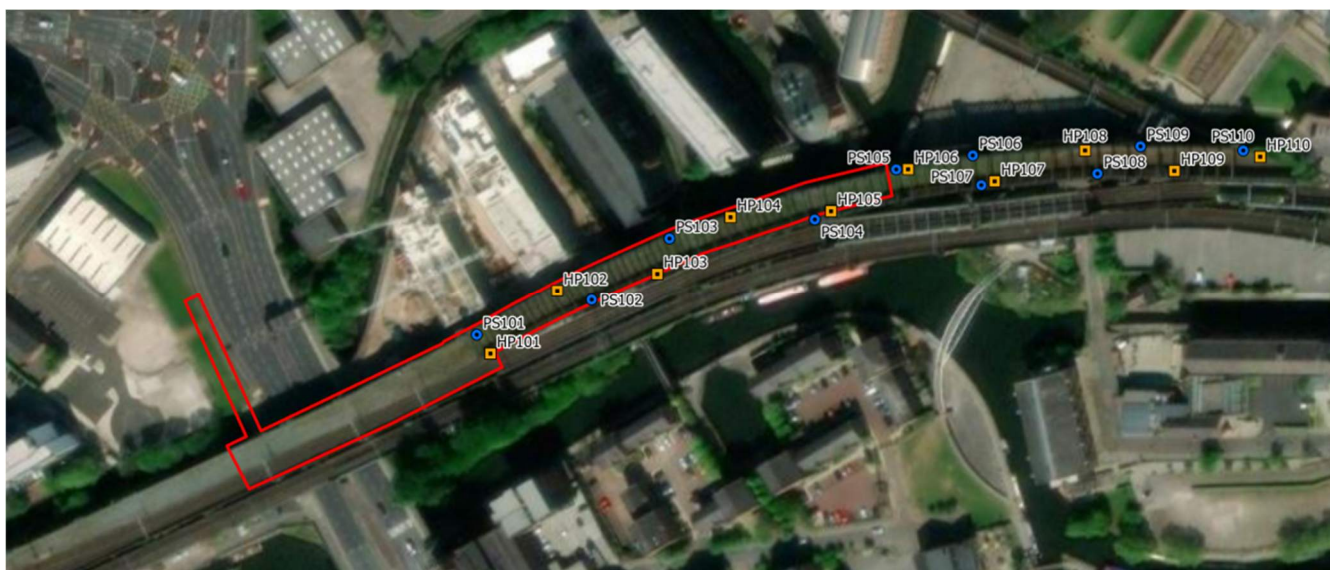


Figure 3: Existing GI Location Plan

For further information, see the Royal Haskoning DHV (2021) *Castlefield Viaduct, Manchester, Land Quality Interpretive Ground Investigation and Generic Quantitative Risk Assessment Report* [6]

During this investigation hand dug pits were excavated at ten locations across the viaduct to a maximum depth of 0.3m below ground level (mbgl). HP101 encountered a timber sleeper at 0.25mbgl whilst the rest of the hand dug pits reached the metal base of the viaduct. The general stratum found consisted of grass over dark brown sandy gravel with occasional rootlets. The gravel is fine to coarse, angular to subangular granite ballast with hydrocarbon staining.

3.4 Radon

The Groundsure Report indicates that there is a low risk from radon at the site, with less than 1% of properties exceeding the Radon Action Level. Therefore, no radon protective measures are deemed necessary for the site.

3.5 Hydrology and hydrogeology

The bedrock geology is classified as a Principal Aquifer. This is defined as layers with high intergranular and fracture permeability, usually providing a high level of water storage and may support water supply or river base flow on a strategic scale. The site is not within a source protection zone (SPZ). Groundwater was encountered at a depth of 22mOD in the nearest historic BGS borehole record.

The River Medlock is culverted beneath Egerton Street adjacent to the proposed lift shaft and the River Irwell is 150m west of the site.

3.6 Flooding

The Environment Agency (EA) flood mapping indicates the risk of flooding from rivers and the sea. From this, the area directly below the site is within flood zone 3 (high probability).

The EA dataset states the highest risk of surface water flooding is a 1 in 30-year rainfall event where surface water levels could be between 0.1m and 0.3m above existing ground level.

3.7 Environmental permits and incidents

Data on environmental permits, waste exemptions, licensed industrial activities and reported pollution incidents are included in the Groundsure report. None apply to the site or immediately adjacent sites.

3.8 Landfills

No recorded waste sites are located on site and waste sites in the wider surrounding area are not expected to be relevant to the proposed development.

3.9 Unexploded ordnance (UXO)

The site has been assessed to have a moderate to high risk and the assessment indicates that action to mitigate the risk is considered essential. As such the procurement of a Detailed UXO Risk Assessment Report should be obtained.

4. Preliminary geoenvironmental assessment

4.1 Approach

Land contamination can present an environmental liability and a constraint to site development. The principal UK legislation related to land contamination is contained within Part 2A of the Environmental Protection Act 1990. Only land where unacceptable risks are clearly identified, after a risk assessment has been undertaken in accordance with guidance, should be considered as meeting the Part 2A definition of contaminated land. In England policy relevant to site development is set out in National Planning Policy Framework (NPPF) (updated September 2023).

The central objectives of the land contamination regime across the UK are the prevention of significant harm, promotion of sustainable development and a “suitable for use” approach to land remediation. It is founded upon the promotion of a risk assessment approach to managing land contamination, focusing on establishing where risks to human health or the wider environment are unacceptable, and then taking appropriate and cost-effective action to deal with these risks.

Across the UK a source-pathway-receptor approach to contamination risk assessment and management is applied based upon the development of a conceptual model for the site, which identifies potential pollutant linkages. The “source” is defined as any contamination on the site, which may impact one or more “receptors”, including people, plants, ecosystems, building materials and water resources. For there to be a contaminant linkage, and therefore a potential risk, there must be a “pathway” between the source and the given receptor. The conceptual site model (CSM) is used to articulate and systematically guide assessment of risks associated with contamination at the site.

For the purposes of this CSM, understanding of the site history and anticipated ground conditions have been used to identify the potential risks to human health and the groundwater environment.

This preliminary geoenvironmental risk assessment has been prepared to inform decisions related to possible sources of contamination identified at the site. The risk assessment follows the UK approach to assessing contaminated land as outlined in the Land Contamination: Risk Management guidance [7].

4.2 Possible sources

The Castlefield Viaduct has been used as railway land since the 1800s. The viaduct is covered in ballast and vegetation. Paint has been observed to be flaking off the steel spans on the viaduct in the east of the site. The land beneath the viaduct has historically been occupied by industrial land uses associated with the canal and railway line.

Where available, the Department of Environment (DoE) Industry Profiles [5] and existing ground investigation information [9] was used to identify possible contaminants and are summarised in Table 3.

Table 3: Possible contaminants based on sources of historical land use

Possible Source	Potential Contaminants	Comments
Ballast on viaduct structure	Asbestos Heavy metals Phenols Sulphates Polycyclic aromatic hydrocarbons (PAHs) Fuel oils, lubricating oils and greases	Ground investigation undertaken in the east of the site in 2021 [9] recorded elevated concentrations of lead and PAHs (chrysene and benzo(a)pyrene). No asbestos was detected in the samples analysed. Some hydrocarbon staining was observed on the ballast and soils were reported to have an oily/greasy feel. Soil leachate samples obtained in 2021 recorded elevated concentrations of lead and PAHs (fluoranthene and benzo(a)pyrene). No ground investigation information is currently available for the ballast in the west of the site, however contamination conditions are likely to be similar.

Paint flaked off from steel spans on viaduct structure	Heavy metals	Samples of paint were taken from the steel span during the 2021 ground investigation including those which cross the eastern part of the site. The paint was found to contain high concentrations of lead and zinc.
Made ground associated with historical development at ground level beneath viaduct structure	Asbestos Heavy metals Extremes of pH Hydrocarbons PAHs Sulphates	No site-specific ground investigation data is available. Available nearby historical BGS borehole logs indicate made ground is likely to contain ash fill with variable brick, concrete, coal, sandstone and iron foundry furnace slag.

4.3 Receptors

The proposed development involves the creation of an urban park along the viaduct with a lift shaft and stair access at ground level in the west of the site. Potential receptors both during construction and after completion of the development include:

- Construction workers and site neighbours during development;
- Future site users and maintenance/ ground workers of the new development;
- Groundwater within the Principal aquifer (Bedrock);
- Surface water within River Medlock and Bridgewater Canal; and
- Future building materials and utilities.

4.4 Pathways

Potential pathways that may be present during construction and operational phases of development include:

- Human health – ingestion of soils, dust or paint flakes;
- Human health – inhalation of dust, vapour or paint flakes;
- Human health – dermal contact with soils and groundwater;
- Controlled waters – leaching of contaminants from soils at ground level into groundwater;
- Controlled waters – leaching of contaminants from soil on viaduct and migration via surface drainage;
- Controlled waters – migration of dissolved phase contamination within groundwater;
- Controlled waters – migration via preferential pathway created by piling at ground level;
- Ground gas – ingress of ground gas into buildings;
- Building materials and utilities – direct contact with soils.

4.5 Contamination assessment

4.5.1 Soil human health risks

The viaduct is covered with a layer of ballast and ground investigation undertaken in the east of the site has identified the presence of elevated concentrations of metals and PAHs which could pose a potential risk to human health where site users come into contact with soil on site. The ballast will be removed from the viaduct and disposed off-site during the construction works. Clean soil will be imported to site to form soft landscaping areas of the urban park. Therefore, there will be no risk to future site users from contact with ballast as this potential source of contamination will be removed.

The steel spans on the viaduct which cross the eastern part of the site are covered in paint that has been identified as containing elevated concentrations of metals (lead and zinc). The paint has been observed to have deteriorated and flakes of paint are present on the ballast. There is a risk that future site users could be exposed to contaminants in the paint flakes by direct contact and ingestion pathways. During the development works the steel spans will be brushed down to remove any loose paint and all paint flake debris will be swept up and removed from site prior to installation of the urban park. While this will prevent paint flaking on the urban park in the short term, over the longer term there may be continued degradation of the steel span and any remaining paintwork may flake off and be deposited on the soil surface within the park. A new balustrade, spaced off the steel spans, will be installed within the park to prevent members of the public from getting too close to the paintwork. While exposure to the paint for future site users is possible it is considered unlikely that members of the public would be interfering with the paint work on the steel spans or disturbing the soils within the park where paint flakes may be present and therefore there will be a low risk to future site users from direct exposure to the viaduct paintwork.

Made ground is anticipated to be present at ground level where the lift shaft and stair access will be installed. The area immediately surrounding the access point at ground level will be covered in hardstanding which will prevent future site users from coming into direct contact with soils in this part of the site and therefore the risks to future site users are considered to be very low.

The biggest risk from interaction with soils onsite arises during the construction works, both on the viaduct and at ground level. There is a possibility that the made ground, ballast and paint flakes may pose a short-term risk to human health for the construction workforce via potential exposure pathways including dermal contact, dust/fibre inhalation and ingestion pathways outdoors. There is also a possible risk to site neighbours during construction via dust/fibre inhalation exposure pathways. Such risks can be mitigated by the contractor following standard good practice during construction and adoption of adequate health and safety procedures, including use of PPE. Appropriate working procedures would be incorporated into a construction environmental management plan (CEMP).

4.5.2 Controlled waters risk

The ballast layer on the viaduct has been identified as having potentially leachable contaminants. The ballast will be removed from the viaduct during the development therefore the risk of contaminants leaching out of the ballast and entering nearby surface watercourses via the surfaced drainage network on the viaduct is negligible.

Any contamination present in made ground at ground level where the lift shaft and stair access will be constructed may pose a risk to controlled waters through leaching and transport in groundwater. The final development will be covered in hardstanding which will limit any infiltration and leaching of contaminants and therefore risks to controlled waters are considered to be low. Ground investigation will be undertaken to assess contamination conditions in this part of the site and further assessment will be undertaken if significant contamination is encountered.

Piling or deeper excavations at ground level has the potential to mobilise any contaminants in made ground and create a preferential migration pathway into groundwater in the underlying Principal aquifer (Chester Pebble Beds Formation). Available historical BGS borehole logs indicate that the made ground beneath the site may be in direct contact with the underlying bedrock and therefore piling may not create a new contaminant pathway, and the risk is considered low. The extent of soil contamination will be identified during ground investigation and if evidence of significant soil contamination is identified a piling works risk assessment will be prepared.

4.5.3 Buried structures and services

Buried structures and services may be at risk from corrosion or degradation as a result of the direct contact with contaminants in made ground and, for example, naturally elevated sulphate levels.

If any new buried structures or utilities are required at ground level, these risks can be mitigated by the selection of appropriate materials for buried services and concrete design. Risks to buried structures and services requires assessment in the context of ground contamination at the site.

4.5.4 Summary of conceptual site model

A summary of the plausible pollutant linkages requiring assessment in relation to the site is presented in Table 4.

Table 4: Summary of conceptual model

Sources		Pathways		Receptors	Comments
Ballast on the viaduct	→	Direct exposure via dermal contact, ingestion or inhalation of soils, dust or fibres	→	Site workers during construction and site neighbours	Ground investigation undertaken to date has identified the presence of elevated concentrations of metals and PAHs within the ballast. No elevated concentrations of volatile contaminants have been recorded. Ground investigation to be undertaken in west of the site to assess contamination conditions. Appropriate site management protocols to be adopted during construction works.
		Inhalation of volatile contaminants	X		
	X	Direct exposure via dermal contact, ingestion or inhalation of soils, dust or fibres	→	Future site users and maintenance workers	The ballast will be removed from the viaduct and disposed off-site during construction works. Soft landscaping areas within the urban park will be created using imported clean soil cover.
	X	Leaching of contaminants and migration via surface water drainage network	→	River Medlock, Bridgewater Canal	The ballast will be removed from the viaduct and disposed off-site during construction works. Therefore, there will no source of leachable contaminants.
Paint flakes on viaduct steel spans	→	Direct exposure via dermal contact, ingestion or inhalation of paint	→	Site workers during construction and future maintenance workers	Appropriate site management protocols to be adopted during construction and maintenance works.
				Future site users (members of public)	Paintwork to be brushed down and debris removed during construction which will reduce risk of flaking paint in short term, however longer-term deterioration could still occur. Balustrade to be installed to prevent members of the public from coming into close contact with the paintwork. Exposure is possible but unlikely that future site users would be interfering with paintwork.
Made ground at ground level	→	Direct exposure via dermal contact, ingestion or inhalation of soils, dust or fibres	→	Site workers during construction and site neighbours Maintenance workers	Site-specific ground investigation information to assess contamination conditions is not available. Ground investigation to be undertaken. Appropriate site management protocols to be adopted during construction and maintenance works.
		Inhalation of volatile contaminants	→		

Sources		Pathways		Receptors	Comments
Made ground at ground level	→	Direct exposure via dermal contact, ingestion or inhalation of soils, dust or fibres	X	Future site users	Site-specific ground investigation information to assess contamination conditions is not available. Ground investigation to be undertaken to assess ground conditions. Hard standing on ground surface will prevent future site users from coming into direct contact with soils.
	→	Creation of preferential migration pathway via piling	→	Groundwater within bedrock geology (Principal aquifer)	Site-specific ground investigation information to assess contamination conditions is not available. Ground investigation to be undertaken. Historical borehole records indicate that made ground directly overlies the sandstone bedrock and therefore piling is unlikely to create a new migration pathway. Further assessment following ground investigation and confirmation of foundation design. If evidence of significant soil contamination is encountered, a piling works risk assessment would be prepared.
Leachable contaminants in the made ground at ground level	X	Vertical migration of dissolved phase contamination	→	Groundwater within bedrock geology (Principal aquifer)	Site-specific ground investigation information to assess contamination conditions is not available. Ground investigation to be undertaken. The final development will be covered in hardstanding which will limit infiltration and leaching of any contaminants. No further assessment unless ground investigation identifies significant soil contamination.
		Lateral migration of dissolved phase contamination in groundwater	→	River Medlock and Bridgewater Canal	
Soils aggressive to building materials at ground level	→	Direct contact with aggressive soils	→	Buried concrete Buried water supply pipes	Ground investigation is recommended to assess whether contaminated soils are present. Selection of appropriate concrete design and materials for buried services.

5. Engineering considerations

5.1 Ground model

Using available ground investigation information, a preliminary ground model for the site is presented below for the western end of the scheme near the proposed lift shaft and staircase.

Table 5: Ground model summary based on nearby BGS borehole record SJ89NW1297.

Strata	Description	Top mbgl (Elevation mOD)	Base mbgl (Elevation mOD)	Thickness (m)
Made Ground	Firm brown sandy clay with brick fragments and ash. Layer of iron foundry furnace slag observed at 6.2m to 7.5m.	0.0 (27.72)	8.2 (19.52)	8.2
Weathered Sandstone	Brown fine to medium grained highly weathered sandstone.	8.2 (19.52)	10.0 (17.72)	1.8
Sandstone	Weak reddish brown medium grained sandstone.	10.0 (17.72)	Not proven	Not proven

Although not observed in the nearest historic BGS borehole records, alluvium deposits associated with the River Medlock (soft organic sands and clays) may be present underlying the made ground.

Groundwater level is expected to be in connection with the River Medlock and was encountered at a depth of 5.7m (22mOD) in the nearest historic BGS borehole record.

5.2 Existing structures

A culvert and two railway viaducts are in proximity to the proposed lift location. The lower level railway viaduct associated with Manchester South Junction and Altrincham Railway, was built by the late 1840s and the higher level railway viaduct associated with the Cheshire Lines Committee was built by the early 1890s.

The Egerton Street bridge which culverts the River Medlock below is located below the western extent of the Castlefield Viaduct. The bridge and culvert extents may have been widened during the construction of the Manchester Ring Road completed in early 2000s. The northern arch of the bridge is located approximately 15m north of the proposed lift shaft and the brick abutment is located approximately 10m away.

The lower level railway viaduct has vertical red brick bridge piers are assumed to be founded in the bedrock approximately 7mbgl in this location. The closest bridge pier is located approximately 15m away from the proposed lift shaft.

The higher level railway viaduct, built within the earlier phases of the Castlefield Viaduct is immediately adjacent to the proposed lift shaft. The blue engineered brick bridge arches and piers are assumed to be founded in the bedrock approximately 8mbgl in this location. Between the blue engineered brick bridge piers are red brick retaining walls, retaining over 8m of variable made ground materials. Both the brick viaduct piers and the retaining walls are estimated to be similar in age, predating the opening of the Castlefield viaduct in 1892.

The culvert, existing railway viaducts and associated retaining walls are considered sensitive structures. Structural condition surveys are recommended to be undertaken prior to any construction works to assess if there is any existing damage.

5.3 Buried obstructions, soft ground and voids

Other than the structures listed in the previous section, no other structures or buildings have been constructed in the location of the proposed lift.

The northern extension of the red line boundary, there have historically been residential houses and a warehouse that have been present on site. Relict foundations from historical structures may be present below existing ground levels.

It is likely that obstructions may be located in the area of the proposed lift, such as the retaining wall foundation which may be corbelled at depth.

The composition of made ground is variable, it will likely contain cobbles and in some locations contain iron foundry furnace slag (a dense granular deposit) as observed in BGS borehole record SJ89NW1297 in a thickness of 1.3m (see Table 4).

Voids may be associated with any period of uncontrolled backfilling, redundant utilities or any partially infilled basements associated with historical development in the northern extent of the site.

Historical poor backfilling of made ground may lead to the presence of shallow localised soft spots. The presence of soft alluvial clays given the proximity to watercourse may also be present.

Buried obstructions, soft spots and voids may impact temporary works and foundation solutions, and their presence should be investigated as part of an intrusive ground investigation.

5.4 Shallow Groundwater

In the location of the lift shaft and stairwell, groundwater level is expected to be in connection with the River Medlock and was encountered at a depth of 5.7m (22mOD) in the nearest historic BGS borehole record.

Given the historical development at the site, there is also potential for shallow perched ground water within the made ground and residual substructures.

The ground investigation should include the installation of standpipes to allow ground water levels to be determined and monitored.

For the remainder of the Castlefield Viaduct scheme at viaduct level, the presence of groundwater does not need to be considered.

5.5 Foundations

Lateral spatial constraints due to proximity to the blue engineering brick arches and pier of the Castlefield Viaduct and the variable made ground materials present, a shallow foundation is not considered to be practical. A piled foundation is the preferred foundation solution transferring load to more competent sandstone, located approximately 8m below existing ground levels.

Given the proximity to sensitive structures, described in Section 5.2, the design of piled foundations / lift pit excavation will have to limit vibration, in addition to considering limited headroom associated with the Castlefield Viaduct above.

At this early design stage, a 450mm bored pile is considered feasible with a restricted headroom piling rig to install pile foundations underneath the viaduct. Sectional flight auger piling may be required where headroom for the piling rig mast and auger is restricted. Confirmation of the pile arrangement, diameter and length will be undertaken at detailed design.

5.6 UXO

The site has been assessed to have a moderate to high risk and the assessment indicates that action to mitigate the risk is considered essential. A Detailed UXO Risk Assessment Report should be obtained.

6. Geotechnical and geoenvironmental risk register

Register reference – Castlefield Viaduct, Manchester Geotechnical and Geoenvironmental Risk Register

Project Castlefield Viaduct **Job number** 282210-00

Package/ topic Desk Study **Design stage** For Information

Remember: Avoid – Reduce – Control and communicate relevant information to others

Date (+ initials)	Area/location of risk exposure	Description of hazard and risk exposure	Mitigation of risk (potential or achieved)	A	R	C	Further action	By	Status
									Active/closed
26/07/24 ZK	Lift shaft Stair case	Buried obstructions or voids impacting time and cost of ground investigation and construction activities.	Ground investigation to assess extent of buried obstructions on site.			✓	Once risk is established during ground investigation, foundation technique to consider the potential for encountering obstructions.	Arup/ Contract or	Active
26/07/24 ZK	Site wide	Risk of clashing with utilities during ground investigation and construction works.	Obtain utility plans/GPR survey in advance of ground investigation.			✓	Designer to avoid known services where possible. Contractor to take appropriate precautions during works.	Client/ Contract or	Active
26/07/24 ZK	Viaduct	Contamination causing risk to human health of workers during construction.	Appropriate working methods and health and safety protocols to be adopted during construction to prevent exposure to potential contaminants. Additional ground investigation to be undertaken to assess contamination of ballast in the west of the site.			✓	Undertake risk assessment on basis of additional ground investigation findings. Appropriate working methods to be incorporated into CEMP.	Arup/ Contract or	Active
26/07/24 ZK	Ground level	Contamination causing risk to human health of workers during construction.	Appropriate working methods and health and safety protocols to be adopted during			✓	Undertake risk assessment on basis of additional ground investigation findings.	Arup/ Contract or	Active

Register reference – Castlefield Viaduct, Manchester Geotechnical and Geoenvironmental Risk Register

Project Castlefield Viaduct **Job number** 282210-00

Package/ topic Desk Study **Design stage** For Information

Remember: Avoid – Reduce – Control and communicate relevant information to others

Date (+ initials)	Area/location of risk exposure	Description of hazard and risk exposure	Mitigation of risk (potential or achieved)	A	R	C	Further action	By	Status
									Active/closed
			construction to prevent exposure to potential contaminants. Ground investigation to be undertaken to assess contamination.				Appropriate working methods to be incorporated into CEMP.		
26/07/24 ZK	Lift shaft and stair case at ground level	Contamination causing risk to water environment.	Ground investigation to assess ground conditions			✓	If evidence of significant soil contamination is encountered, collect groundwater samples for geoenvironmental testing.	Arup/ Contract or	Active
26/07/24 ZK	Lift shaft and stair case at ground level	Migration of contamination into underlying aquifer due to foundation piling.				✓	If evidence of significant soil contamination is encountered, prepare a piling works risk assessment.	Arup/ Contract or	Active
26/07/24 ZK	Lift shaft Stair case	Shallow groundwater impacting construction works	Undertake groundwater monitoring during ground investigation			✓		Arup/ Contract or	Active
26/07/24 ZK	Site wide	Risk of encountering unexploded ordnance (UXO) during ground investigation and construction works.	Detailed UXO Risk Assessment to be carried out			✓	Follow recommendations of Stage 2 Detailed UXO Risk Assessment.	Client/ Contract or	Active
26/07/24 ZK	Lift shaft and stair case at ground level	Potentially high sulphate concentration in the ground can attack any proposed buried infrastructure.	Collect samples for BRE Special Digest 1 testing.			✓	Concrete sulphate class to be designed following ground investigation.	Arup/ Contract or	Active

Register reference – Castlefield Viaduct, Manchester Geotechnical and Geoenvironmental Risk Register

Project	Castlefield Viaduct	Job number	282210-00
Package/ topic	Desk Study	Design stage	For Information

Remember: Avoid – Reduce – Control and communicate relevant information to others

Date (+ initials)	Area/location of risk exposure	Description of hazard and risk exposure	Mitigation of risk (potential or achieved)	A	R	C	Further action	By	Status
									Active/closed
26/07/24 SC	Lift shaft Stair case	Damage to sensitive structures (bridge, retaining walls, viaducts) which may risk further damage and collapse	Conduct structural condition survey prior to construction works.		✓	✓	Selection of foundation technique to reduce vibration.	Arup/ Contract or	Active

7. Conclusions and recommendations

7.1 Conclusions

Based on a review of the available data, ground conditions on site are expected to comprise of made ground consisting of sandy clay, brick fragments and ash. There is a layer of iron foundry furnace slag observed at 6.2m to 7.5m depth, with weathered sandstone below. Groundwater is likely in connection with the River Medlock, encountered at approximately 5.7mbgl around the lift shaft location. For the remainder of the Castlefield Viaduct scheme at viaduct level, the presence of groundwater does not need to be considered.

The viaduct is covered in ballast and vegetation.

Earliest available mapping shows a bridge crossing the River Medlock adjacent to the Bridgewater Canal and wharf. A lower level railway viaduct associated with Manchester South Junction and Altrincham Railway, was built by the late 1840s and the higher level railway viaduct (Castlefield Viaduct) was built by the early 1890s. Heavy industry is shown in the surrounding Castlefield area associated with the canal and railway.

Heavy industry shown on available historical maps in the surrounding area includes, but not limited to chemical works, cotton and paper mills, iron works, engineering works and a variety of warehouses. These may pose a constraint to future development.

Due to the likely presence of compressible soils to significant depths, it is assumed that piled foundations will be required for the proposed lift shaft and staircase.

Possible sources of contamination at the site include the ballast along the viaduct, flaking paint from the steel viaduct structure in the east of the site and made ground associated with historical development at ground level. The conceptual site model identified potential risks to construction workers, future site users, groundwater and building materials.

Intrusive investigation is required to establish the extent and nature of chemical contamination to inform risk assessments, as well as informing geotechnical assessment and foundation design. The geotechnical and geoenvironmental risk register identifies mitigation is available and can be implemented as part of the proposed scheme to address all identified ground-related risks. A detailed UXO Risk Assessment Report should be obtained prior to intrusive works.

7.2 Recommended outline scope of ground investigation

It is recommended that a development specific intrusive ground investigation specific is undertaken.

Ground investigation objectives include the following:

Location A (on the viaduct)

- Excavation of 5 No. hand dug pits in the west of the site to a maximum depth of 0.3mbgl for ballast sampling and contamination testing;
- Collection of soil samples for laboratory geoenvironmental testing;

The 2021 ground investigation data for the eastern part of the viaduct is considered sufficient to inform the risk assessments.

Location B (beneath viaduct span)

- Excavation of 1 No. cable percussion boreholes with rotary follow on boreholes to a maximum depth of 15mbgl. Initial hand dug trial pit excavation required for utility detection;
- 1 No. machine dug trial pit to maximum 4.5m depth below ground level to establish retaining wall and viaduct pier foundation geometry;
- Collection of soil samples for laboratory geotechnical and geoenvironmental testing;
- Production of a combined factual report on the ground investigation covering both locations.

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Appendix A

Curtins Phase 1 Ground Conditions Report

Appendix B

Royal Haskoning Land Quality Desk Study and Preliminary Risk Assessment

Appendix C

Land Quality Interpretive Ground Investigation and Generic Quantitative Risk Assessment Report