

# **Etihad Campus – Site Improvement Works**

## **Specification for Stabilisation of Mine Workings by Grouting**

**NSE-BHE-XX-XX-TS-CG-000002**

**053810**

28 July 2023

Revision P03

| Revision | Description                                            | Issued by | Date     | Checked |
|----------|--------------------------------------------------------|-----------|----------|---------|
| P01      | Preliminary – Subject to Environment Agency agreement. | COH       | 10/02/23 |         |
| P02      | Preliminary – Subject to Environment Agency agreement. | COH       | 10/03/23 |         |
| P03      | Stage 4A: (S4) – for review and approval               | COH       | 28/07/23 | AKS     |

[https://burohappold.sharepoint.com/sites/053810/05\\_Teams Files/Ground Engineering/Specifications/NSE-BHE-XX-XX-TS-CG-000002\\_Grouting Spec\\_P03.docx](https://burohappold.sharepoint.com/sites/053810/05_Teams%20Files/Ground%20Engineering/Specifications/NSE-BHE-XX-XX-TS-CG-000002_Grouting%20Spec_P03.docx)

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date **28<sup>th</sup> July 2023**

approved **Alice K Shrubshall**

signature 

date **28<sup>th</sup> July 2023**

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# 1 General Requirements/Information

## TO BE READ WITH THE PRELIMINARIES/GENERAL CONDITIONS

**NOTE:** This document includes requirements issued and agreed with the Environment Agency which form part of the planning requirements for the scheme.

### Definitions

- 1.1 The 'Employer' means Manchester City Football Club and includes the employer's successors.
- 1.2 The 'Engineer' means BURO HAPPOLD or other Engineer appointed from time to time by the Employer and notified in writing to the MC and WC to act as Engineer, for the purpose of the Contract in place of BURO HAPPOLD.
- 1.3 The 'Contractor' means the Principal or Main Contractor.
- 1.4 'Works Contractor (WC)' means the specialist drilling and grouting subcontractor.

### Name of Contract

- 1.5 Etihad Campus – Site Improvement Works – Stabilisation of Mine Workings by Grouting.

### Location and Description

- 1.6 The Site is centred on grid reference SJ 86784 98665 located at Manchester City Football Club, Ashton New Road, Bradford, Manchester M11 3HY. It is located to the northeast of Manchester City centre, approximately 2km northeast of Manchester Piccadilly Rail Station.
- 1.7 The ground level is approximately +59mOD, rising slightly to the east toward Gibbon Street and Alan Turing Way (to around +61mOD). The Site occupies approximately 2.6 ha and is located within the Etihad Campus. It is bound to the north by the tramline and station (with Ashton Canal beyond), to the east by Alan Turing Way (A6010), to the west are the National Squash Centre and the Manchester Regional Arena, and to the south is the Manchester City Football Club Stadium
- 1.8 The area is predominantly covered by hardstanding associated with services to the Stadium. There are localised areas of gravel hardstanding typically around the ground anchors for the Stadium roof. The Stadium itself occupies the southern portion of the Site, approximately 50m north is Manchester City Store. Surrounding the store are numerous shipping containers that are used as food stalls during event days.
- 1.9 To the west of the Store is an electricity substation (located within the Store building). Beyond the Store, further north are covered areas (canopies) with bars and public toilets. These areas also include seating, tables and raised planters.

### Proposed Development

- 1.10 The proposed activities include Site Improvement Works, the purpose of which is to futureproof any future development by grouting to depths of envisaged base of piles to manage future movements.
- 1.11 The distribution of coal seams beneath the site is summarised in Paragraph 2.11.

## Design Criteria

- 1.12 The WC shall be fully responsible for the design and execution of the grouting works, including the provision of all materials in accordance with this performance specification. It shall be the duty of the WC to select materials that are suitable for their intended use and free of inherent defects. The design shall be submitted to Buro Happold for review in advance of starting on site.

## Standard of Acceptance

- 1.13 The general specification for the grouting works shall be the CIRIA C758D “Abandoned mine workings manual”.
- 1.14 The concrete works shall be carried out in accordance with BS 8004:2015+A1:2020.
- 1.15 The foregoing documents shall apply as a minimum standard of acceptance in respect of matters not covered in this Specification.

## Setting Out

- 1.16 All grout holes to be set out to an accuracy of 0.25m of the detailed design position. If it is not possible to locate the exploratory hole at the specified position, alternative locations are to be proposed that are more practicable. All grout locations will need to be carefully coordinated with the numerous existing utilities located on site.
- 1.17 As-built co-ordinates of the grout holes are to be recorded to an accuracy of 0.1m horizontally and 10mm in elevation.

## Noise and Vibration

- 1.18 The WC shall comply with the general recommendations of BS 5228, the “Code of Practice for Noise and Vibration Control on Construction and Open Sites”, together with any specific requirements described in the Contract Documents. This will include provision of adequate noise and vibration information to satisfy stakeholders (including but not limited to service providers) that their working methodologies will not cause damage or disruption to adjacent assets.

The assumed limits from Cadent are as below:

“Any piling or boring work within 15m of any buried gas plant should not be allowed without an assessment of the vibration levels at the location of the gas plant. For steel and PE the peak particle velocity at the asset should be limited to 75mm/sec. Where the PPV is predicted to exceed 50mm/sec, an assessment of the asset stress state, which includes the incremental load due to vibration, is required. For cast iron or ductile iron asset the PPV should not exceed 25mm/sec.”

The contractor should note that other stakeholder may have more onerous requirements and are responsible for obtaining these requirements and complying with them.

## Security

- 1.19 Once a borehole has commenced, it shall be completed continuously and without undue delay. Any borehole remaining open overnight shall be adequately temporarily protected and covered in a safe manner.

### Quality Management System

- 1.20 All work shall be carried out in accordance with relevant quality management systems for fieldwork, laboratory testing and reporting (BS EN ISO, UKAS/NAMAS and MCERTS).
- 1.21 All boring and drilling operatives, including Lead Drillers and Drillers (Drilling Support Operatives), employed on the contract shall be suitably experienced and qualified and hold a valid and current audit card of competence, for example as issued by the British Drilling Association Ltd or an equivalent body in a State of the European Union. This shall be applicable to the work and specific drilling operation on which they are engaged.
- 1.22 The WC shall give written instructions to their site staff on all relevant aspects of this specification such as sampling frequency, groundwater records and the procedure required for dealing with obstructions. NOTE: tubular steel piles associated with the existing Club shop (to be demolished prior to the drilling and grouting works) are understood to remain in-situ during the works.

### Professional Attendance

- 1.23 The WC shall provide sufficient site management and superintendence and Professional Attendance to perform the tasks detailed in this specification.

## 2 Scope of Work

### General Requirements

- 2.1 The envisaged Works shall consist of the drilling and grouting of shallow mine workings and any associated fractured or broken ground within the area generally indicated on the contract drawings (Appendix A refers). At this stage, the foundation design intent assumes a maximum pile length of 27 m. This will be subject to detailed design by the specialist piling contractor. Based on the current foundation design intent above, it is envisaged that the grouting works will penetrate beyond the base of piles to 30 m BGL. It should be noted that as part of the GEL 2022 ground investigation, no voids were recorded during drilling of the 8 No. boreholes. However, fractured zones of rock along with flush loss during the drilling process were recorded. As such, the design intent is to grout any fractured or broken ground along the pile length and 3m beyond the pile base. The WC is responsible for establishing the required maximum depth of grouting and no liability is accepted for adoption of the design intent.
- 2.2 This specification is in respect of the treatment of possible abandoned coal mine workings situated below the proposed development. Again, the above should be noted in respect of the absences of voids recorded during 2022. The purpose of the works is to stabilise any fractured zones in the top 30m of ground to futureproof the base and shaft resistance of any future piling works across the site. This involves the stabilisation, by drilling and bulk grouting of former coal workings and the treatment of any disused mineshafts, adits or bell pits encountered on site by accepted methods.
- 2.3 The proposed ground treatment works are generally in accordance with the guidance outlined in CIRIA C758D "Abandoned mine workings manual".
- 2.4 It is envisaged that the ground will be treated in the area indicated on the drawings (subject to the WC's design), such that future upward migration of any voids present or consolidation of fractures is limited and any potential settlement of the proposed development is minimised. During the grouting process the WC's method of working should not give rise to any ground settlement or heave. Where the WC believes that the Specification compromises their best working practice or may lead to the above requirements not being met, then the WC shall inform the Engineer in writing at the earliest opportunity so that the method of working can be reassessed.
- 2.5 Prior to commencement of the Works the WC shall produce a Method Statement or Method Statements to cover all aspects of the Works and shall submit this/these to the MC for approval. Such documentation will also need to be submitted and approved by both the Environment Agency and Coal Authority as part of a pre-commencement submission.
- 2.6 The WC should take note of the specific health and safety requirements regarding the works in close proximity to adjacent highways and property and the requirements of the Coal Authority as outlined in Paragraph 2.19, in addition to any special requirements (Section 12 refers).
- 2.7 All British Standards, Specifications and British Standard Codes of Practice or any other standards referred to in this specification shall be the latest standards including all amendments published before the last day of returning tenders, unless otherwise stated.
- 2.8 The WC is responsible for all co-ordination with the Coal Authority including obtaining licences, general coordination to facilitate and undertake the Works.
- 2.9 The envisaged proposed area to be grouted is presented in Appendix A. The WC is to review all available information and provide their design for review by the Contract Administrator and Engineer prior to commencement.

- 2.10 Work is required in close proximity to the existing backstay foundations which are tension foundations and for the stadium roof structure as well as other key foundations. These are a critical part of the existing structure and the grouting designer will need to take account of these historic foundations and anchor designs and their associated zones of influence in their grouting proposals. Based on the available historic information, it is understood that the ground anchors are installed to a nominal 2.5 degrees from the vertical (as built records contained in the City of Manchester Stadium Health and Safety Files, Volume B13B and B13C). With regards to the grouting works, it is assumed that the pressure under which the grout is placed will not be sufficient to cause any displacement to the existing anchors. On this basis the recommended exclusion zone around each anchor for the grouting works is 1m radially around the centre of the anchor. The grouting contractor is responsible for reviewing their drilling tolerances and the as built records to ensure that this exclusion zone is complied with.

### Grouting Philosophy

- 2.11 The distribution of coal seams beneath the site is summarised as follows:
- Several coal seams are present beneath the site, some of which have the potential to have been historically worked.
  - The strata dip toward the southwest, hence the coal seams progressively increase in depth further to the southwest.
  - During the site specific GEL 2022 GI, a number of seams were encountered in the majority of boreholes. Although no voids were recorded in the drilling logs, more heavily fractured zones were encountered and drilling flush was recorded to be lost during drilling in a number of holes.
  - The envisaged Works shall consist of the drilling and grouting of shallow mine workings and any associated fractured ground within the area generally indicated on the contract drawings (Appendix A refers). It is currently envisaged that the works will penetrate to a depth of ~30m BGL.
  - The proposed activities include Site Improvement Works, the purpose of which is to stabilise the more fractured zones within the top 30m and futureproof any future development by grouting the zones affecting base and shaft resistance of any future potential pile design (Section 2.1 refers) to manage pile movements.
  - Reference should be made to the Buro Happold Coal Mining Risk Assessment and Ground Engineering Desk Study (Section 4 refers) for full details.
- 2.12 It is possible that unrecorded/undiscovered shallow workings within the Openshaw and Charlotte (Upper and Lower) Seams are present on site.
- 2.13 The WC should be aware that during the Works or as a result of the Works the following may occur – mine gas emissions, mine water emissions, spontaneous combustion, collapse of shallow mine workings or mine entries.

### Grouting Strategy

- 2.14 Over the area shown on the drawings, grouting techniques shall be adopted to infill voids/fractures in the ground relating to possible former mineworkings. It is not currently proposed to form a perimeter curtain as the existing ground investigation indicates that any workings are not typically open voids below the site, however whether or not a perimeter curtain is required is at the discretion of the WC and to be agreed with the Engineer at tender stage.
- The envisaged Works consist of the drilling and grouting of possible shallow mine workings/fractured ground within the area generally indicated in Appendix A, on a primary 6 x 6m grid; a secondary overlapping 6 x 6m

grid; and the potential requirement for a subsequent tertiary 3m x 3m grid subject to grout takes. Or WC alternative agreed with the Engineer.

- Sequencing will be a consideration due to existing site constraints however it is envisaged that grouting shall start from the deepest part of the seam (i.e. down dip) working up to the shallowest holes i.e. working from the west of the development plot.
- This will enable the ground model to be progressively refined, allowing a more accurate estimate of the depths of the grout holes to follow. It should also verify the assumption not to form a perimeter curtain is appropriate in this case.
- Where disturbed, broken or Made Ground is encountered from ground level or very shallow depth, which could represent a mine entry or the upward migration of a void to the surface (crown hole), additional boreholes to be sunk at close centres until disturbed ground is absent as agreed with the Engineer. In this situation appropriate precautions should be taken by the WC to minimise the risk of ground collapse during drilling.

### Sequence of Drilling and Grouting

- 2.15 The WC shall ensure that the holes are positioned accurately. This shall be based on the site grid established by the MC (Paragraphs **Error! Reference source not found.** to 1.17 refer).
- 2.16 Sequencing will be a consideration due to existing site constraints however it is envisaged that grouting shall start from the deepest part of the seam (i.e. down dip) working up to the shallowest holes i.e. working from the west of the development plot.

### Drilling and Grouting over Suspected Mineshafts

- 2.17 The WC shall state in their Method Statement measures taken to negate the level of risk posed by any unidentified or suspected mineshafts, adits, or bell pits with reference to Section 11.

### Safety

- 2.18 The WC shall supply a Risk Assessment/Method Statement and Safety Plan for the Works. This will need to be submitted and approved by both the Coal Authority and Environment Agency in advance of the works commencing.
- 2.19 The WC shall adopt safe practices during the drilling and treatment of the disused mine workings. Safe practices shall include those specified in the Coal Authority permission and COSHH requirements for material handling. Appropriate PPE precautions shall be used by site personnel.
- 2.20 All plant and equipment used within the designated investigation and treatment areas shall be fitted with spark suppressors and exhaust flame retarders along with any additional requirements set out by the Coal Authority. Smoking and naked flames shall be prohibited.
- 2.21 The WC shall supply an approved gas detector capable of monitoring for carbon monoxide, methane, carbon dioxide and hydrogen sulphide in the area of the Works. The gas detector shall be maintained in operating condition with persons suitably trained in its operation.
- 2.22 The gas detector shall be employed at the start of every shift or before drilling recommences after having been discontinued for more than thirty minutes, to ensure that the locality is free from flammable or toxic gases. The gas monitoring regime will take account of Coal Authority requirements.
- 2.23 The WC is to provide a methodology for securing plant against overturning with their tender return.

**Reinstatement**

- 2.24 On completion of the works the WC will remove from the site of the works and dispose of all surplus materials and spoil arising from the Works. The off-site disposal of all types of arisings (solids and liquids) shall be subject to the relevant waste transport and disposal regulations Waste Management Duty of Care Regulations (Paragraph 8.5 refers).
- 2.25 Unavoidable damage caused by the WC shall be reinstated unless otherwise instructed by the MC.
- 2.26 The WC shall take photographs of potential reinstatement, damage and safety issues as the Works progress.
- 2.27 The Clients requirements in respect of surface reinstatement to drill hole locations will need to be confirmed directly with the Client. Previously during the GEL 2022 Ground Investigation, the Client requirements comprised a like for like reinstatement. Based on the Ground Investigation data available this typically comprised 0.10m of tarmacadam underlain by 0.30m of well compacted Type 1.

### 3 Site Conditions

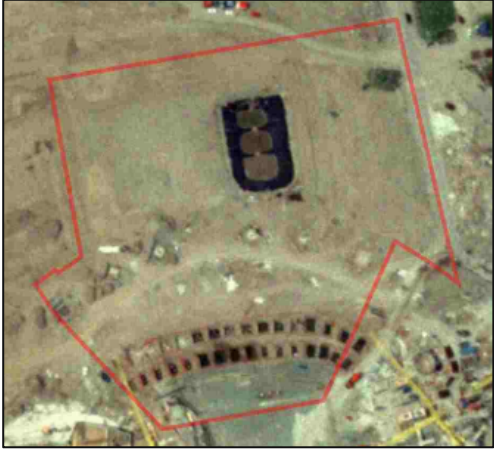
#### General Site History

- 3.1 The Site history and that for the surrounding area has been completed using historic maps from 1848 to 2022. This history is summarised in Table 3-1 below.

**Table 3-1 - Summary of site history and history of the surrounding area**

| Date                           | On site                                                                                                                                                                                                                                                                                                                                                                          | Off site                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1848<br>(OS<br>Map)            | Site occupied by fields with several tracks passing through. These all led to a rectangular building in the centre of the Site which included four no. smaller square structures at the periphery and a large rectangular feature (possible water feature?) to the west of it.                                                                                                   | <p><b>North</b> – Ashton Canal, Lock No. 5 to the northwest and Lock No. 6 to the northeast. Coal Pits to the northeast (south of the canal, opposite Lock No. 6 and west of the canal arm).</p> <p><b>East</b> - An arm off the canal extends southward east of the Site. Beyond this was Bradford Mill (small wares) and Oxley Place. To the southeast are several additional Coal Pits and Bradford Colliery.</p> <p><b>South</b> – A large water feature adjacent to the Water Works reservoir. Bradford Colliery.</p> <p><b>West</b> –Manchester and Salford Water Works Reservoir SW, Coal Pits (approx. 4 no.) beyond. Another water feature NW with Fustian Mill beyond. A Pottery, Coal Pits, Engine House and Brick Kiln, Brick Field all located beyond the reservoir.</p>                                                                                                                          |
| 1890s<br>(OS<br>Map)           | Site shown as developed: residential buildings to the north (off Eldon St, Wood St and Bailey St). Benson St cuts through the centre of the Site (east-west), south of this is Bewick Good Station and associated rail land. Philips Park Road also cut through the north of the Site (east-west, north of the residential developments), beyond this is Gratrix's Mills (Lead). | <p><b>North</b> – Albion Colour Works (dye works) and Gratrix's Mills (lead mill) located between the Canal and Philips Park Road. Beyond the Canal, Bradford Road Gas Works developed.</p> <p><b>East</b> – Forge Lane forms western boundary. Industrial development including Bradford Iron Works, beyond the Canal arm extension: Park Mills (cotton) and African Mills (cotton).</p> <p><b>South</b> – Colliery still present, extension of Bradford Iron Works and associated rail/tram lines. Chapel and significant residential development.</p> <p><b>West</b> – Engineers and Iron Founders Works (includes a chimney). Water Works Reservoir no longer present, presumed infilled, replaced by rail / tram lines connecting to a main line (L.Y.R. Ardwick Branch). Fustian Mill labelled as Reservoir Mill. Brick Field replaced by residential development. Pottery replaced by Cotton Works.</p> |
| 1905 –<br>1908<br>(OS<br>Maps) | Further residential development within north of the Site, between Ashfield St and Middlewood St. Public House in northeast corner.                                                                                                                                                                                                                                               | <p><b>North</b> – Albion Works cleared. Gas works to the north expanded.</p> <p><b>East</b> – Park Mill replaced with residential development. Canal Arm labelled as Colliery Arm.</p> <p><b>South</b> – Slight expansion to the Iron Works south. Beswick Mineral Yard and Goods Shed developed to the SW.</p> <p><b>West</b> – Reservoir Mill no longer labelled<br/>Some additional residential development generally observed (south and west)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Date                    | On site                                                                                                                                                                    | Off site                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1923<br>(OS Map)        | No significant changes recorded on map.                                                                                                                                    | The Archaeological Report [14] explains that c.1914 the Bradford Iron Works was expanded including the addition of a new wire rod mill.<br><br>Slight expansion of Bradford Iron Works further south. Alterations observed within the Colliery. Additional building constructed (assumed industrial) to the NW, near Gratrix's Mill. No other significant changes recorded on maps.                                                                                                                                                                                                                                                                                                     |
| 1930s<br>(OS Map)       | Building developed east of Gratrix's Mill, encroached slightly onto Site (NE corner).<br><br>No other significant changes recorded on map                                  | <b>North</b> – New building to the NW expanded and labelled as Progress Bakery. Additional buildings constructed between Progress Bakery and Gratrix's Mill. Large expansion of Gas Works further north.<br><br><b>East</b> – Canal arm partly developed over by the Iron Works. Some of the residential developments replaced by the Iron Works. African Mill now labelled as Philips Park Printing Works.<br><br><b>South</b> – Further expansion/alterations to Bradford Iron Works (Wire).<br><br><b>West</b> – Construction of a larger Goods Shed within the former Beswick Mineral Yard. Engineering Works shown south of the Mineral Yard. Iron Works labelled as Iron Foundry. |
| 1940s<br>(OS Map)       | No significant changes recorded on map.                                                                                                                                    | No significant changes recorded on map. Bradford Colliery buildings partly cleared.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1950s<br>(OS Map)       | Approximately a third of the residential buildings cleared on Site (between Middlewood St and Eldon St, Eldon St and Beswick Placc and Woolton St and Thronbury St).       | Bradford Colliery buildings redeveloped, although buildings still connected via tram / rail lines to the main line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1968<br>(OS Map)        | Residential development north of Benson Street entirely redeveloped and labelled as Works.                                                                                 | <b>East</b> – Works covering more of the Canal arm, presumed partially infilled.<br><b>West</b> – Further development around the Goods Shed, presumed industrial development.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 1970s<br>(OS Map)       | Travelling Crane occupying north of Site.<br><br>Large building to the south. Few rail lines remain (3 no. total in the south of the Site).<br><br>Gratrix's Mill cleared. | Much of the residential development cleared. Electrical substations shown adjacent north.<br><br>Travel Crane shown east (adjacent) of Forge Lane.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Early 1980s<br>(OS Map) | No significant changes recorded on map.                                                                                                                                    | <b>West</b> – Clearance of several buildings.<br><b>South</b> – Colliery cleared, only shafts remain shown. Large areas of residential redevelopment further south beyond the Iron Works, including development of a school.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Late 1980s<br>(OS Map)  | Site cleared with the exception of Ashfield St, Philips Park Road, Petherton View, the Public House and several other small buildings in the northwest and east.           | <b>North</b> – Bradford Road Gas Works cleared. Gratrix's Mill cleared, other adjacent works still shown.<br><b>East</b> – Works include a travelling crane adjacent to Forge Lane. Canal Arm entirely gone (presumed infilled).<br><b>South</b> – Online sources suggest Bradford Iron Works closed in 1986. Shafts shown as disused. Development of a depot.<br><b>West</b> – Goods Sheds cleared, much of the rail land cleared. The former Cotton Mill shown as a Factory. Foundry still remains.                                                                                                                                                                                   |

| Date                      | On site                                                                                                                                                                                                                                                                                        | Off site                                                                                                                                                                                                                                                                                                                  |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1990s<br>(OS Map)         | Remaining structures on Site shown as cleared.                                                                                                                                                                                                                                                 | Works to the east largely cleared.                                                                                                                                                                                                                                                                                        |
| 2000<br>(Satellite image) | <p>Aerial satellite image shows lagoon located on Site.</p>  <p><b>Figure 3-1 Lagoon shown on 2000 satellite image</b></p>                                                                                    | Surrounding areas shown as cleared with construction activities taking place.                                                                                                                                                                                                                                             |
| 2002 / 2003<br>(OS Map)   | The Site entirely redeveloped to include part of The City of Manchester Stadium (Commonwealth Games). Rectangular building shown north of the Stadium.                                                                                                                                         | Entire area surrounding the Site cleared and replaced with some new developments, namely an athletic track (now known as Manchester Regional Arena) to the west and a large building to the north west (now known as the National Squash Courts). Aland Turing Way labelled to the east and Ashton New Road to the south. |
| 2009<br>(Satellite image) | <p>Aerial satellite image shows the Stadium and Joe Mercer Way as constructed. Stockpile appears to be located within the eastern part of the Site.</p>  <p><b>Figure 3-2 Stockpile shown to the NE</b></p> | Athletics Track, Tennis Centre and National Squash Centre all shown as constructed. BMX track can be seen on land north of Ashton Canal.                                                                                                                                                                                  |
| 2010<br>(OS Map)          | Stadium now labelled as Manchester City FC.                                                                                                                                                                                                                                                    | Joe Mercer Way shown to the north. Athletics track to the west labelled as Regional Athletics Arena.                                                                                                                                                                                                                      |

## Mining Specific History Within 100m of the Site

3.2 A Ground Engineering Desk Study and a Coal Mining Risk Assessment have been completed for the Site.

- Buro Happold, “Etihad Campus – Site Improvement Works – Coal Mining Risk Assessment” December 2022 (ref: ETC-BHE-ZX-XX-RP-CG-0002)
- Buro Happold, “Etihad Campus – Site Improvement Works – Ground Engineering Desk Study” 2022 (ref: ETC-BHE-ZX-XX-RP-CG-0001).

A detailed summary of historic coal mining along with a summary of subsequent remedial treatment that has occurred on site is included in these reports, the details of which are not repeated herein. Appropriate reference should be made to these reports along with the GEL 2022 ground investigation for further understanding on details on the coal mining risks.

## Published Geology

3.3 The 1:50,000 and 1:10,000 geological maps together with borehole logs available from several historical Site investigations indicate the geology to be the Carboniferous Pennine Upper Coal Measures, overlain by superficial deposits namely, Glacial Till.

3.4 Owing to the significant industrial past of the Site area (including Bradford Ironworks and Bradford Road Gas Works) and the nature of redevelopments, Made Ground will be present.

3.5 A number of coal seams are identified to subcrop on site and in close proximity to the site. The BGS map records the following coal seams beneath the site:

- Openshaw Mine,
- Charlotte Mine,
- Three Quarters Mine and
- Bradford Four-foot Mine.

3.6 An extract from the solid geological map, which shows faults and coal seam outcrops/subcrops recorded in the nearby area, is shown as **Error! Reference source not found..**

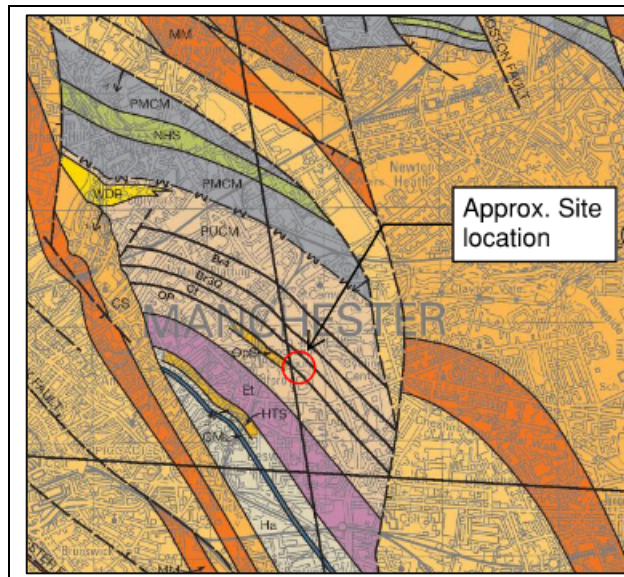


Figure 3-3 Extract of 1:50,000 BGS map (Sheet 85)

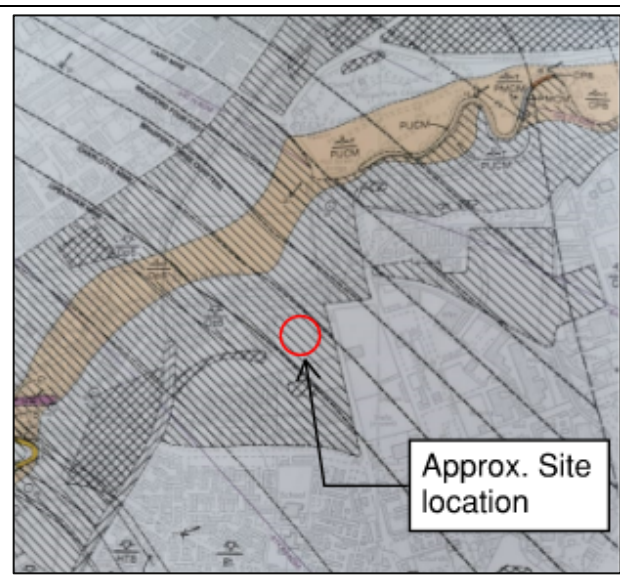


Figure 3-4 Extract of 1:10,000 BGS map (SJ89NE)

## Unpublished Geology

- 3.7 The ground conditions onsite have been assessed on the basis of the available ground investigation (GI) information both for the site and the nearby surrounding area. A site specific ground investigation was also undertaken for the proposed development site in November and December 2022 by Geotechnical Engineering Limited (GEL). In addition, GI data from historical investigations have also been reviewed both onsite and in the immediate surrounding area. The associated reports should be referred to for information, a list of which are provide below in Table 3-2:

**Table 3-2 Summary of ground investigation / remediation reports reviewed within this report**

| Date | Author                                | Title                                                                                                              | Location                                                                                                                       |
|------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| 1991 | Northern Foundations Ltd              | Various documents (S.I. 5400): Appendix A and Appendix B, borehole logs, drawings, groundwater and ground gas data | Eastlands (Etihad Campus area) excludes gas works site.                                                                        |
| 1995 | Northern Foundations Ltd              | Reports on Phase 2 site Investigations at Eastlands, Manchester Plot 16-19 and Plot 23                             | Across the Stadium area                                                                                                        |
| 1998 | Norwest Holst                         | Report on Ground Investigation at Manchester Stadium Area S. Volume 1 to 4.                                        | Across the Stadium area                                                                                                        |
| 2000 | Alfred McAlpine Civil Engineering Ltd | Site Remediation Completion Report                                                                                 | Across the Stadium area                                                                                                        |
| 2010 | May Gurney                            | Site Investigation Report No SI565 Final                                                                           | Across the Etihad Campus area, information relevant to the site includes Area A Central                                        |
| 2011 | Buckingham Group Contracting Ltd      | Remediation Validation Report, Area A Central                                                                      | Across the Etihad Campus area, information relevant to the site includes Area A Central (covers eastern part of the Site only) |
| 2014 | ESG                                   | Report No A3174-13 Factual and Ground Conditions Report - Expansion of North and South Stands                      | Across the northern and southern Stadium expansion areas                                                                       |

- 3.8 The output reports for the investigations undertaken are provided to the Contractor by the Employer for information. Neither the Employer nor the Engineer offer any warranty, guarantee or undertaking of any kind as to the accuracy of these investigations and none should be inferred.
- 3.9 Ground investigation works were also undertaken by Geotechnical Engineering Limited (GEL) specifically for this development in November/December 2022. The scope of the works was as follows:
- 8 No. boreholes to depths between 45m and 65m bgl. Boreholes to be cable percussion with rotary follow on;
  - 3 No. windowless sample holes through the Made Ground (initially trial pits but owing to site constraints altered to windowless sample holes);
  - 4 No. machine excavated trial pits to depths between 3m and 4m bgl, through the Made Ground;
  - 5 No. vacuum excavated observation trenches to depths between 2m and 3m bgl, to identify services;
  - 8 No. static Cone Penetration Testing (CPT)
  - 2 No. In situ California Bearing Ratio (CBR) tests;
  - Standard Penetration Testing (SPTs);
  - Downhole geophysics in selected locations;
  - Standpipe installations within all borehole and window sample locations;
  - Geotechnical and geoenvironmental laboratory testing; and
  - Groundwater and ground gas monitoring (including a six-round post fieldwork monitoring programme).

The ground conditions encountered on the Site are summarised below in table 3-3.

**Table 3-3 Encountered geological conditions**

| Strata        | Description                                                                                                                                                                                                                                                                   | Top of Strata |      | Thickness<br>(average) m |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------|--------------------------|
|               |                                                                                                                                                                                                                                                                               | m BGL         | m OD |                          |
| Made Ground   | Tarmac across the majority of the Site (with the exception of those locations in the east).                                                                                                                                                                                   | 0.0           |      | 0.1                      |
|               | Light grey concrete and limestone GRAVEL (Type 1 material). Occasionally a geotextile identified separating this material from the underlying Made Ground (generally recorded between 0.3 – 0.5m bgl).                                                                        | 0.1           |      | 0.15 – 0.4<br>(0.2)      |
|               | Brown to dark grey silty sandy GRAVEL or sandy gravelly CLAY. Gravel is fine to coarse, subangular to subrounded, brick, concrete, sandstone, limestone, quartzite, clinker, rare glass and metal. Occasional concrete and brick obstructions. Occasional hydrocarbon odours. | 0.3-0.5       |      | 3.0 – 8.0<br>(4.8)       |
| Glacial Till  | Soft to firm light grey mottled light brown slightly sandy silty CLAY.<br>Stiff becoming very stiff brown to grey slightly sandy slightly gravelly CLAY.                                                                                                                      | 3.0 – 8.0     |      | 9.7 – 12.6<br>(11.4)     |
| Coal Measures | Extremely weak to weak light grey to dark grey MUDSTONE. Bedding fractures are sub-horizontal to 20° and sub-vertical to 80°. Mudstone becomes carbonaceous and occasionally tends to black pyritic COAL.                                                                     | 15.0 – 17.7   |      | Not proven               |

| Strata | Description                                                                                                                                                                                                                                     | Top of Strata |      | Thickness<br>(average) m |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|------|--------------------------|
|        |                                                                                                                                                                                                                                                 | m BGL         | m OD |                          |
|        | <p>Moderately weak grey SILTSTONE, locally with thin interlaminated mudstone.</p> <p>Moderately weak light grey fine to medium SANDSTONE with extremely closely to closely spaced thinly and thickly interlaminated mudstone and siltstone.</p> |               |      |                          |

## Coal Seams

3.10 The distribution of coal seams beneath the site is summarised in Table 4-1 below:

**Table 3-4 Likely sequence of coal measure strata beneath the Site**

| Sequence                                                | Approximate thickness      | Description                                                                                                                                                                                                                                                         |
|---------------------------------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Openshaw Mine                                           | ~0.4m                      | Sub-crop located in the southwest of the Site.                                                                                                                                                                                                                      |
| Measures between the Openshaw the Charlotte Mines       | >9m                        | Mainly mudstone with sandstone in the upper part.                                                                                                                                                                                                                   |
| Charlotte Mine                                          | ~10m                       | Sub-crop located within the central part of the Site. Partial collapse reported. Sequence of weak seatearth mudstones with up to three separate coals:<br>0.8-1.1m Coal (worked)<br>2-3m Seatearth<br>0.3-0.4m Coal<br>4-5m Seatearth<br>0.5-1m Coal (often parted) |
| Measures between Charlotte Mine and Thin Coal A         | ~23-25                     | Variable strata sequence, often with thick sandstone in the lower part. Several thin impersistent coal seams 6m, 8m, and 13m above Thin Coal A. The horizon 13m above the Thin Coal A has been locally worked as the Charlotte Coal.                                |
| Thin Coal A                                             | -                          | Sub-crop located within the east of the Site. Thin, but persistent coal.                                                                                                                                                                                            |
| Measures between Thin Coal A and B                      | ~21m                       | Mainly mudstone, often dark at top & base of sequence.                                                                                                                                                                                                              |
| Thin Coal B                                             | -                          | Sub-crop located within far northeast of the Site. Thin, but very persistent coal.                                                                                                                                                                                  |
| Measures between Thin Coal B and C                      | ~16m                       | Often dark mudstone with ironstone bands.                                                                                                                                                                                                                           |
| Thin Coal C                                             | -                          | Thin, but persistent coal.                                                                                                                                                                                                                                          |
| Measures between Thin Coal C and Bradford ¾ Mine        | ~20m                       | Mainly mudstone, some sandstone bands. Thin Coal sometimes present ~6m below Thin Coal C.                                                                                                                                                                           |
| Bradford ¾ Mine                                         | ~0.8m                      | Often worked horizon. Occasionally absent.                                                                                                                                                                                                                          |
| Measures between Bradford ¾ Mine and Bradford Four-foot | ~16m                       | Mainly mudstone, thick sandstone horizon in places.                                                                                                                                                                                                                 |
| Bradford Four-foot Mine                                 | ~2-2.5m (coal and parting) | Complex horizon. Extensively worked. General sequence:<br>1-1.5m Coal<br>1m Seatearth<br>0.1m Coal                                                                                                                                                                  |

3.11 It is to be noted that the coal seam thicknesses have been estimated from historical ground investigation information based on the encountered coal and/or voids due to workings or poor recovery. Additional seams are located beneath the Bradford Four-foot seam however, these are unlikely to impact the design owing to their depth down dip.

## Hydrology

3.12 Ashton Canal is located to the north of the Site, beyond the Metrolink (35m north). The Canal climbs for 10.8km through 18 locks toward Ashton-under-Lyne. Lock No. 9 is located nearest to the Site, resulting in a

3.5m ground level change.

- 3.13 The River Medlock is located about 160m northwest of the Site and flows south and west toward the River Irwell in Manchester City Centre. The course of the River Medlock once meandered through the land north of the Site (within the Co-op Live arena development site). By the early 1890s it had been diverted and realigned northwards. Then by 1905, the River was contained within a 600m-long culvert below the former Bradford Road Gas Works site. There is an entrance opposite Philips Park (>300m north) and another entrance to the northwest of the Site by Ashton Canal Park (>300m west).



**Figure 3-5 Extract from the Groundsure Report, showing the location of the River Medlock and Ashton Canal (blue dashed lines) relative to the site.**

### Hydrogeological Regime

- 3.14 The Coal Measures are classified as Secondary (A) Aquifer defined as permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow to rivers. There are two groundwater abstractions located within 1km of the Site. The Site is not within a groundwater source protection zone. The abstractions are related to the following:

- Borehole at premises at Clayton, Manchester. Ciba Specialty Chemicals Plc (>950m southeast).
- One borehole at Openshaw, West Ashton, Manchester. Associated with Manchester City Football Club (>950 southeast)

### Contamination Management / Aquifer Protection

- 3.15 To minimise contamination the WC shall provide spill kits (minimum 1 per drill rig / excavator / other plant) and train personnel in their use. Drip trays shall be located beneath any static plant, such as generators, hydraulic power packs etc. Any contamination shall be contained and reported to the MC immediately.
- 3.16 All drilling and excavation plant and equipment should be clean and jet-washed before commencing works in a new area to avoid cross-contamination.
- 3.17 Special aquifer protection measures are not generally required. However if the WC encounters evidence of gross contamination during drilling, they should immediately contact the MC / Engineer who will instruct

whether special measures should be adopted. These may include the installation of a bentonite plug as detailed in the ICE UK Specification for Ground Investigation - Clause 3.15.3.

- 3.18 The WC shall ensure that no pollution or siltation occurs to any surface watercourses as a result of the works.
- 3.19 Special monitoring requirements are required by the Environment Agency - details of which are provided in Clauses 8.20 to 8.27 herein.

### **Hazardous Ground**

- 3.20 The Contractor shall implement best practice and industry accepted methods (as required) to mitigate the risk related to presence of buried unexploded ordnance (UXO) during the works. A detailed UXO risk assessment has been undertaken and is provided within the following report:
- 6Alpha Associates (October 2022). "Detailed Unexploded Ordnance (UXO) Threat and Risk Assessment, MCFC North Stand." Project Number 10147.

The findings of the above 6Alpha detailed UXO risk assessment advise a UXO risk rating of low.

- 3.21 The WC shall ensure that all equipment is free from flora and fauna before being brought onto or removed from the site. The same checks must be made when transferring any equipment from one area to another. The WC shall notify the Engineer / MC if Japanese Knotweed lies within 20m of an exploratory hole location or access route to that location – none envisaged.
- 3.22 No notifiable and invasive plant species (as defined by the Wildlife and Countryside Act, 1981) or their relevant exclusion zones are known to be present at the time of writing this Specification. If identified within the working area by the WC during the course of the works, the presence of these plants shall be notified immediately to the Engineer / MC.
- 3.23 Numerous existing buried services are known to exist on site and a series of surveys and records are available – The WC should familiarise themselves with all the relevant service information/drawings/diversions information available. No damage/adverse effects to existing services is allowed.
- 3.24 Work is required in close proximity to the existing backstay foundations which are tension foundations for the stadium roof structure. these are a critical part of the existing structure and the grouting designer will need to take account of these historic foundations and anchor designs and their associated zones of influence in their grouting proposals. Based on the available historic information, it is understood that the ground anchors are installed to a nominal 2.5 degrees from the vertical (as built records contained in the City of Manchester Stadium Health and Safety Files, Volume B13B and B13C). With regards to the grouting works, it is assumed that the pressure under which the grout is placed will not be sufficient to cause any displacement to the existing anchors. On this basis the recommended exclusion zone around each anchor for the grouting works is 1m radially around the centre of the anchor. The grouting contractor is responsible for reviewing their drilling tolerances and the as built records to ensure that this exclusion zone is complied with.

### **Protected Species**

- 3.25 The WC is to ensure that no harm comes to any flora or fauna. The exception is necessary clearance of flora for access to complete the Works as shall be agreed between the WC and the MC (if required).

### **Anomalous Conditions**

- 3.26 Where anomalous or unexpected features are revealed during the site works (such as underground obstructions, visual or olfactory evidence of significant contamination, artesian water pressures etc.), the WC

shall immediately inform the MC / Engineer. NOTE: tubular steel piles associated with the existing Club shop (to be demolished prior to the drilling and grouting works) are understood to remain in-situ during the works.

- 3.27 It is the responsibility of the WC to satisfy themselves as to the suitability of their equipment and working methods to suit the conditions existing on site.

## 4 Information Provided

4.1 The following information is provided to enable the WC to prepare their design specification and/or tender:

- Historic Site Investigation reports / remediation reports :
  - As detailed in Table 3-2 herein.
- Geotechnical Engineering Limited Factual Report (2023)
- Provisional indicative area to be grouted (Appendix A refers).
- Reports produced by Buro Happold:
  - Buro Happold, “Etihad Campus – Site Improvement Works – Coal Mining Risk Assessment” December 2022 (ref: ETC-BHE-ZX-XX-RP-CG-0002).
  - Buro Happold, “Etihad Campus – Site Improvement Works – Ground Engineering Desk Study” 2022 (ref: ETC-BHE-ZX-XX-RP-CG-0001).

## 5 Services

- 5.1 Numerous existing buried services are known to exist on site and a series of surveys and records are available – The WC should familiarise themselves with all the relevant service information/drawings/diversions information available. No damage/adverse effects to existing services is allowed
- 5.2 The WC shall state in the submitted Method Statement how they intend to undertake the Works with regards to the presence of statutory services. Details of stand-off distances, changes in grouting pressure and any other relevant information shall be included. This will include provision of adequate noise and vibration information to satisfy stakeholders (including but not limited to service providers) that their working methodologies will not cause damage or disruption to adjacent assets.

The assumed limits from Cadent are as below:

“Any piling or boring work within 15m of any buried gas plant should not be allowed without an assessment of the vibration levels at the location of the gas plant. For steel and PE the peak particle velocity at the asset should be limited to 75mm/sec. Where the PPV is predicted to exceed 50mm/sec, an assessment of the asset stress state, which includes the incremental load due to vibration, is required. For cast iron or ductile iron asset the PPV should not exceed 25mm/sec.”

The contractor should note that other stakeholder may have more onerous requirements and are responsible for obtaining these requirements and complying with them.

All United Utilities requirements associated with drilling/working within UU infrastructure and associated easements must be established and agreed prior to any works commencing and adhered to during the works.

- 5.3 The WC is responsible for any costs of breakage, damage and interruption of supply. Confirmation will be required that appropriate insurance is held.
- 5.4 When introducing grout into any borehole the WC shall ensure by twice daily inspections (refer to Clauses 8.20 to 8.27 herein) that the grout is not entering adjacent drains, services, culverts and ducts. In the event that any such leakage is detected the WC shall immediately suspend the grouting operations and commence the removal of any accumulated grout.
- 5.5 The WC shall provide and maintain all temporary drains, channels, sumps and catch pits that may be necessary to prevent the blocking of drains leading from the site with water borne materials resulting from their operations. The WC shall ensure that all drains leading from the site are maintained in a free running condition at all times during the contract to the satisfaction of the MC / Engineer.

## 6 Materials, Mixes and Testing

### Constituent Materials for Grouting

- 6.1 Water shall be from the mains supply or other source advised by the MC and/or Employer. All water used in the Works shall be clean, fresh water, free from impurities. The MC shall make suitable arrangements to ensure a proper and sufficient supply for the duration of the Works.
- 6.2 Cement shall be Sulphate Resisting Portland cement (SRPC) complying with BS 4027.
- 6.3 PFA shall comply with BS EN 12715: 2020 and be conditioned hopper ash, or dry powder ash, or a type suitable as a constituent for grout and obtained from an approved supplier. If an alternative to PFA is proposed, this must be pre-agreed with the Engineer at tender stage, and the WC must be satisfied that the alternative materials are capable of providing the same filling, consolidation and treatment credentials as PFA grouts.
- 6.4 Sand shall generally comply with BS EN 12620: 2002 + A1: 2008 and be of a grading suitable for use in the WC's plant and suitable for the Scope of the Works and the nature of the ground conditions.
- 6.5 Pea gravel shall comply with BS EN 12620: 2002 + A1: 2008 and be of a grading suitable for use in the WC's plant and suitable for the Scope of the Works and nature of ground conditions. Thixotropic admixtures shall be bentonite or another admixture advised by the WC for the Scope of the Works and the nature of the ground conditions.
- 6.6 Grout mixes used shall be in general accordance with the CIRIA C758D "Abandoned mine workings manual".

### Storage and Use of Materials

- 6.7 The WC shall ensure that all materials are stored and protected so as not to deteriorate, become damaged or contaminated, nor to hinder their works, nor to cause unnecessary disturbance to the site, nor cause nuisance on or away from the site of the Works.
- 6.8 Storage of materials shall be such as to prevent contamination and deterioration. Cement shall be kept in a dry location and the sequence of deliveries recorded so that cement can be used in rotation.
- 6.9 PFA shall be stored under impermeable covers which shall be weighted down to prevent dust nuisance and to retain moisture. The WC shall take all necessary steps to ensure that windblown PFA does not constitute a nuisance.
- 6.10 Unsuitable materials identified on site shall be marked in an obvious manner (until taken to a waste tip) to ensure they are not used.
- 6.11 Details of quantities of delivery of materials should be provided to the MC and copied to the Engineer.

### Grouting Plant

- 6.12 The WC shall submit details of the proposed method of mixing and pumping of grout to the injection points, together with the means of monitoring grouting pressures and the quantities injected. The materials shall be introduced into the mixer via approved weight batching equipment. Special attention must be paid to the moisture content of materials not delivered dry to the site and this must be taken into account in order to maintain the water/solids ratio of the grout being manufactured at any time on the site.

- 6.13 Water used during the preparation of grout shall be introduced into the mix by means of a measuring device and at no time shall water be introduced into the mixer prior to the complete discharge there from of the previous batch of mixed grout.
- 6.14 The grout mixer shall be capable of producing a homogenous mix, all particles being thoroughly wetted without segregation.
- 6.15 Provision shall be made for monitoring the quantity being delivered from the grouting plant. The WC shall supply details of the method of monitoring and calibration of equipment.

### Grout Mixes

- 6.16 The current envisaged grout mixes based on performance requirements are as detailed below. The design should be provided to the Contract Administrator and Engineer for review in advance of the works commencing.
- Cement: PFA = 1:10.
  - If any grouting point takes a grout quantity of more than 5 tonnes then the grout mix is to be changed to 5:4:1 PFA:sand:cement (or WC alternative agreed with the Engineer).
  - The minimum cementitious content shall be 75 kg/m<sup>3</sup> in dry or unsaturated conditions. In waterlogged workings, the minimum cement content should be 100 kg/m<sup>3</sup> to allow for dilution effects in waterlogged workings.
  - If open voids are encountered (defined by a gravity fall of more than 300mm during drilling) then the addition of sand or pea gravel to the mix in accordance with CIRIA C758D will be considered. Should this occur, details to be provided by the WC to the Contract Administrator and Engineer for review.
  - For large or interconnecting cavities exceeding 500mm high, pea gravel infilling shall be used to limit grout travel outwith the area of consolidation.

### Grout Properties and Testing

- 6.17 With water / (cement and PFA) ratios generally in the range of 0.40 to 0.45 (including the moisture in the aggregates) the mixes proposed should produce pumpable grout with flowability readings of between 300mm and 600mm when measured in a meter of the "Colcrete" type.
- 6.18 The sample for the flowability test shall be obtained by the WC at the point of injection i.e. from the end of the tremie pipe. A minimum of two flowability tests per day or per batch as appropriate shall be performed by the WC whichever is the greater.
- 6.19 High-bleed grouts shall be avoided. Bleed capacity should be limited to 5% maximum unless agreed otherwise with the Engineer.
- 6.20 A minimum of two bleed capacity test shall be performed by the WC per shift or as directed by the Engineer. The sample of grout for the test shall be taken from the point of injection i.e. the end of the tremie pipe.
- 6.21 Bleed capacity readings shall be at hourly intervals from 2 hours after monitoring starts for not less than 6 hours until settled conditions occur. Bleed capacity should be measured in a clear plastic or glass graduated cylinder, which has an internal diameter not less than 50mm and with a volume of approximately 1000ml. After placing the (fly ash: cement) grout, a cover should be placed over the cylinder to avoid evaporation.
- 6.22 For strength testing, the WC shall make sets of four test cubes of an agreed size and taken from the grouting pipe, at surface positions, every 24 hours or as agreed with the Engineer. The cubes shall be marked, handled,

stored and tested by an approved independent testing laboratory in accordance with BS 1881 to confirm the projected 3, 7 and 28-day strengths of the grout. Crushing strengths shall be not less than 0.9 MN/m<sup>2</sup> at 28 days. (Note: the 7 day test is performed to indicate that the 28 day strength is achievable i.e. a 7 day value of about 0.4 MN/m<sup>2</sup> is considered to be on target).

- 6.23 If the results of the tests indicate that a change of mix proportions is required, the WC shall agree such modifications as may be necessary with the Engineer. The WC shall ensure further testing of the cubes by an independent testing laboratory in accordance with BS 1881 to confirm the projected 3, 7 and 28-day strengths of the grout.

## 7 Drilling Procedures

### Drilling Procedures

- 7.1 The envisaged Works shall consist of the drilling and grouting of shallow mine workings and any associated fractured or broken ground within the area generally indicated on the contract drawings (**Error! Reference source not found.** refers). At this stage, the foundation design intent assumes a maximum pile length of 27 m. This will be subject to detailed design by the specialist piling contractor. Based on the current foundation design intent above, it is envisaged that the grouting works will penetrate beyond the base of piles to 30 m BGL. It should be noted that as part of the GEL 2022 ground investigation, no voids were recorded during drilling of the 8 No. boreholes. However, fractured zones of rock along with flush loss during the drilling process were recorded. As such, the intent of the grouting is to grout any fractured or broken ground along the pile length and 3m beyond the pile base.
- 7.2 All boreholes to be used for the injection of grout, including those which strike coal pillars, shall be drilled by rotary or rotary percussive techniques down to a 30 m BGL (see above intent). The drilling system and flushing medium to be used shall be as instructed on the Coal Authority licence for the Works. The WC shall allow for the provision of appropriate dust suppression for those holes that are to be drilled near sensitive receptors (e.g. nearby houses, highways, railways, active commercial properties, car parks and public footpaths).
- 7.3 The minimum diameter of the holes shall be 75mm unless otherwise specified. Where it is impracticable to drill at the minimum diameter for the full depth, the diameter of the boreholes shall be increased in the upper lengths. If the WC considers that the diameter should be increased to facilitate the flow of grout, particularly for perimeter holes, this should be advised at the time of tender and priced accordingly. The verticality and inclination of all vertical drill holes shall be checked prior to commencement of drilling using an inclinometer against the drill rods. The vertical holes shall be to an accuracy of +/- 1° from vertical measured by this method. It should also be noted that where existing utilities or similar constraints prevent the use of vertical drill holes, inclined drilling may be required.
- 7.4 Boreholes shall be temporarily cased through superficial deposits and/or Made Ground down to the rockhead and, if necessary, down through the rock strata. The boreholes shall be kept open, if necessary the holes shall be kept open by means of a series of steel/alkathene tubes (tremie) or temporary casing placed to the bottom of the hole, until grout injection into the workings and rock is complete. The WC should ensure that the temporary casings do not allow loss of grout to superficial strata overlying rockhead.
- 7.5 Where drilling returns are 'lost' owing to the presence of loose ground, cavitated ground or water bearing strata, drilling shall proceed no deeper than 5 metres below the depth at which returns were lost. If after drilling the 5 metres without a re-establishment of the returns, the WC shall terminate drilling at that position or to insert casing to such a depth that drilling returns are re-established.
- 7.6 The WC shall recover from all drilled holes all grout tubes, drill rods, casing or other equipment. No equipment shall be abandoned in a drilled hole without the written consent of the Engineer. No recompense will be made for any casing abandoned in any hole on completion of the Works.
- 7.7 Where a borehole proves abortive because it becomes obstructed, it shall be re-drilled in a suitable location agreed with the Engineer within 24 hours, at a larger diameter and re-cased, or a new hole drilled and cased. Prior to commencement on site, a general methodology for relocation of obstructed boreholes is to be agreed between the WC and the Engineer.
- 7.8 The envisaged works shall consist of the drilling and grouting of shallow mine workings and any associated fractured ground within the area generally indicated on the contract drawings (Appendix A refers) on a

primary 6m x 6m grid with the potential requirement for a subsequent secondary 3m x 3m grid subject to grout takes, or WC alternative agreed with the Engineer. Grout hole depths are currently envisaged to 30m depth (subject to WC design).

- 7.9 Sequencing will be a consideration due to existing site constraints however it is envisaged that grouting shall start from the deepest part of the seam (i.e. down dip) working up to the shallowest holes.
- 7.10 If crown holes or shafts are suspected to be present, drilling may be instructed down to 1.00m centres. The grouting hole spacings may alter during the course of the Works should the ground conditions dictate.
- 7.11 Upon completion of grouted areas, a number of pressure injection test holes will be drilled and grouted at locations to be agreed with the Engineer to assess the adequacy of the Works (Section 9 refers). The final number of tests required will be a function of the findings during the works and the final configuration of the works upon completion. An allowance of 12 No. pressure injection test holes is recommended at this time (to be reviewed upon completion of the works).
- 7.12 Work is required in close proximity to the existing backstay foundations which are tension foundations for the stadium roof structure. These are a critical part of the existing structure and the grouting designer will need to take account of these historic foundations and anchor designs and their associated zones of influence in their grouting proposals. Based on the available historic information, it is understood that the ground anchors are installed to a nominal 2.5 degrees from the vertical (as built records contained in the City of Manchester Stadium Health and Safety Files, Volume B13B and B13C). With regards to the grouting works, it is assumed that the pressure under which the grout is placed will not be sufficient to cause any displacement to the existing anchors. On this basis the recommended exclusion zone around each anchor for the grouting works is 1m radially around the centre of the anchor. The grouting contractor is responsible for reviewing their drilling tolerances and the as built records to ensure that this exclusion zone is complied with.

## Sequence of Works

- 7.13 The grouting works specified herein are critical to the overall construction programme. The works will need to be closely coordinated with the MC to ensure there are no delays.

## 8 Grouting Procedures

### General

- 8.1 Sequencing will be a consideration due to existing site constraints however it is envisaged that grouting shall proceed systematically from the deepest point of the workings (Paragraph 7.8 refers).

### Water Supply and Site Cleanliness

- 8.2 The WC is required to make provision for supply of water and other services required for grouting operations and to provide for the disposal of surplus grout and slurries produced in cleansing plant and in any other part of the operation.
- 8.3 The WC shall keep the site clean and tidy at all times during the work and at the completion of the work.
- 8.4 The WC shall make provision to prevent any grout spillage or run-off from the site by construction of a suitable sump or provide a portable collecting tank. The WC shall not contaminate or cause to be contaminated any watercourses or water supplies.
- 8.5 Unless otherwise agreed with the MC, the WC will be required to produce and maintain a Site Waste Management Plan (SWMP) for the Grouting Works. The WC shall be responsible for disposal of all excess materials and arisings off-site. Any waste water arisings shall be collected and appropriately stored to await classification. The off-site disposal of all types of arisings (solids and liquids) shall be subject to the relevant waste transport and disposal regulations Waste Management Duty of Care Regulations.

### Site Procedure

- 8.6 Immediately prior to grouting each hole, the WC shall check that it is unobstructed to the required depth to receive the tubing or pipes for grouting. Obstructions shall be dealt with as described in 'drilling procedures' (Section 7). NOTE: tubular steel piles associated with the existing Club shop (to be demolished prior to the drilling and grouting works) are understood to remain in-situ during the works.
- 8.7 Grout shall be tremied into position down each hole via a series of steel/alkathene tubes placed to the bottom of the hole, until grout appears at the surface, whereupon the tremie pipe will be withdrawn. In Infill and Attenuation Curtain grout holes, the grout line at the surface shall be attached to an approved T-connection with an attached pressure gauge fixed to the top of the drill hole. Provision shall be made for monitoring the quantity being delivered in the line.
- 8.8 The grout shall be injected at the approved rates until either a limiting pressure of 10kN/m<sup>2</sup> per metre of overburden or a maximum of 200kN/m<sup>2</sup> is reached, or when grout appears near the point of injection, when the hole shall be deemed complete. If one of these criteria is reached quickly, the grout tube or pipes shall be lifted to check that a local obstruction is not preventing the flow of the grout into the strata. Grout injection shall continue at gauge pressures as temporary casing is withdrawn.
- 8.9 Care shall be taken to ensure that uplift pressures are not allowed to develop under any adjacent services or structures during grout injection. Where nearby buildings or structures might be affected by the grouting operations, the WC shall employ special supervision, and, unless otherwise agreed with the Engineer, the WC shall monitor ground levels by precise levelling at intervals, both prior to and during operations. The WC is entirely responsible for ensuring that no damage to existing structures and existing services results from the injection operations.

- 8.10 If pressure is not achieved or grout does not appear at the point of injection after 5 tonnes of grout materials have been placed, the grout tube or pipe shall be removed from the hole and injection suspended. After a period of at least 12 hours the grout mix shall be changed to 5:4:1 PFA:sand:cement (or WC alternative agreed with the Engineer), as set out in Paragraph 6.16, and up to a further 5 tonnes of materials shall be injected. If there is still no result, injection shall again be suspended for at least 12 hours and the process shall be repeated with further quantities of 5 tonnes. If the hole is still accepting grout after a total of 20 tonnes of materials have been injected without any sign of the hole being completed, the WC shall consult the Engineer to determine whether the injection is to be continued or other measures such as secondary or test holes are required.

### **Perimeter Curtain Wall (if required)**

- 8.11 It is not proposed to form a perimeter curtain as the existing ground investigation indicates that any workings are not typically open voids below the site, however whether or not a perimeter curtain is required is at the discretion of the WC and to be agreed with the Engineer at tender stage.
- 8.12 When grouting the curtain wall, to avoid excess pressure causing the cone to slump, the grout flow should be stopped as soon as the cone has reached the roof of the seam and has formed a good interlock as far as reasonably practicable.
- 8.13 When the perimeter curtain grout has set sufficiently hard, the hole, if required, shall be filled to the surface with grout injected at a maximum of 10kN/m<sup>2</sup> per metre of overburden with an upper limit of 200kN/m<sup>2</sup>, whatever the depth of the hole. The same procedure shall apply if the hole is cased through rock, grout injection continuing as the casing is withdrawn.

### **Infill Grouting**

- 8.14 The Works shall consist of the drilling and grouting of shallow mine workings and any associated fractured ground within the area generally indicated on the contract drawings (Appendix A refers) on a primary 6 x 6m grid; a secondary overlapping 6 x 6m grid; and the potential requirement for a subsequent tertiary 3m x 3m grid subject to grout takes. Or WC alternative agreed with the Engineer. Grout hole depths are currently envisaged to 30m depth (subject to WC design).
- 8.15 Should the grouting of infill holes be required, these shall proceed systematically from the deepest point of the workings (Paragraph 7.8 refers), care being taken to ensure that the perimeter curtain wall (if applicable) is sufficiently far in advance of the infilling works. Infill holes shall not be grouted until at least 6 hours have elapsed since the curtain wall grouting was completed and is at least three rows in advance of the primary infilling.
- 8.16 Injection shall be carried out as described under general procedure, but immediately the grout tubes, or pipes, are withdrawn, the T-connection shall be attached to the top of the casing lining the hole down to rockhead, and further grout shall be injected up to the specified pressures.

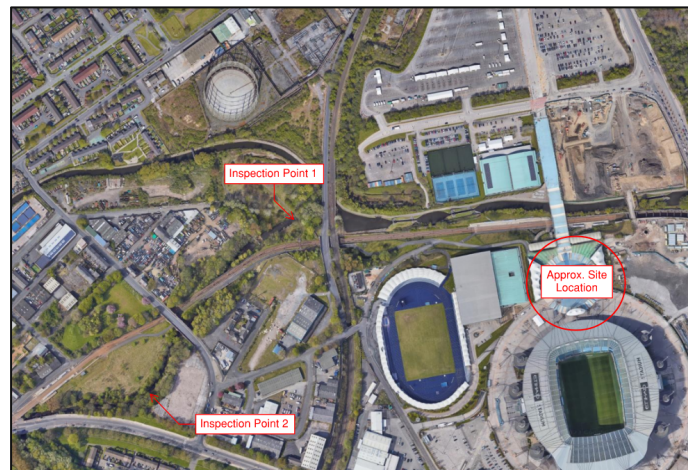
### **Escape of Grout and Ground Heave**

- 8.17 The WC is solely responsible for ensuring the grout is not allowed to penetrate any nearby drains, sewers, culverts, service ducts and cellars, etc. The WC shall employ a site supervisor and shall regularly inspect all services in the vicinity of the site to ensure the absence of grout.
- 8.18 Where grouting works are carried out adjacent to any services or structures, the WC shall employ special supervision, and shall monitor ground levels by precise levelling at intervals, both prior to and during operations.

- 8.19 The ground levels surrounding boreholes shall also be visually monitored and work shall be suspended should any ground heave be noted.

### **Groundwater Monitoring – (AS REQUIRED BY THE ENVIRONMENT AGENCY FOR PLANNING PURPOSES)**

- 8.20 A series of groundwater monitoring wells (8 No.) have been installed as part of the GEL 2022 Ground investigation. Groundwater level baseline readings (daily) should be obtained during the 2 weeks prior to commencement of grout works.
- 8.21 During grouting works, groundwater levels in each of the monitoring wells are to be monitored twice daily during the works (morning and afternoon readings to be obtained).
- 8.22 Provision should be made for additional monitoring in areas where grout takes are higher than expected and / or where there is a consistent and suspect rise in groundwater levels. In such circumstances monitoring of groundwater levels in relevant wells (i.e. wells in vicinity of grout injection) should be undertaken at hourly intervals for up to one day [Note: Other management action will also be undertaken in such circumstances and will be detailed within the selected contractor's method statements];
- 8.23 At the completion of the works, all groundwater level monitoring data to be provided to form a part of the Contractor's Completion Report; and
- 8.24 All boreholes to be decommissioned upon completion of the improvement works (in accordance with EA guidance
- 8.25 Visual inspection and recording of quality of the surface water at two locations (image below refers) in conjunction with the groundwater level monitoring. That is twice a week for the 2-weeks prior to the grouting works and twice a day during the works – with provision for additional inspection;



- 8.26 The surface water monitoring record shall consist of a photo and note of condition at each location (IP 1 and IP 2) on every occasion; and
- 8.27 At the completion of the works, all surface water condition monitoring records to be provided to form a part of the Contractor's Completion Report.

## 9 In-situ Testing

- 9.1 Permeability by grout acceptance testing shall be checked by drilling 20 No. test holes in positions to be agreed with the Engineer and then injecting grout at pressures in accordance with the requirements for infill grouting and outlined in Section 8. The injection pressure will require to be held for an appropriate period of time (approx. 5 mins). Appropriate casing, capable of sustaining the test pressures, should be used. If the Engineer considers that the quantities of grout accepted are excessive, further holes shall be drilled and grouted.
- 9.2 After testing, holes shall be completed in accordance with the requirements for grouting infill holes.
- 9.3 The WC shall prepare and keep available for inspection on site, plans showing the positions of all boreholes, daily drilling records (Section 10 refers), together with the total amounts of grout injected. Levels shall be given with reference to a datum to be confirmed by the MC or Engineer.
- 9.4 The Engineer may, in addition, require core samples to be taken by rotary core drilling to check the adequacy of the grouting operation. Should any test reveal incomplete consolidation or other defect, the WC shall carry out additional grouting and tests as directed by the Engineer. Any defects considered by the Engineer to be due to workmanship or procedures not in accordance with the Specification or the WC's own design and method of working shall be made good at no additional cost to the Employer.

## 10 Records

- 10.1 The WC shall prepare, and keep available for inspection on site, plans showing the positions of all holes. Records, in the form of cross-sections through the rows of holes, to show the results of the Works (in particular the information in Items 9, 10 and 14 to 21 inclusive of the Daily Drilling Records below – Paragraph 10.7), together with the total amounts of grout injected shall be maintained.
- 10.2 The plans and sections shall be up-dated daily in conformity with the Records noted below. On completion of the Works, the WC shall give fair copies of the plans and sections to the MC and the Engineer within one week of completion of the programme of grouting.
- 10.3 As work proceeds, the WC shall maintain separate daily records for drilling, for grouting and for materials and plant received in a form to be approved by the Engineer. The daily records signed by the WC's agent shall be submitted each day to the MC for their agreement. The WC shall provide one copy of the agreed record for the MC's retention and keep a further copy available for inspection on site.
- 10.4 A series of groundwater monitoring wells have been installed as part of the GEL 2022 Ground investigation. Groundwater level baseline readings (daily) should be obtained during the 2 weeks prior to commencement of grout works and the data recorded.
- 10.5 Groundwater levels in each of the monitoring wells are to be monitored twice daily during the works (morning and afternoon readings to be obtained) and the data recorded.
- 10.6 Daily checks are to be undertaken of the River Medlock, both upstream and downstream, during the works (morning and afternoon visual checks and photographic records to be taken) and the data recorded.
- 10.7 Daily Drilling Records shall be provided for each borehole and contain the following information:
- 1 Job title and location.
  - 2 Hole reference number.
  - 3 Date.
  - 4 Contractor's name.
  - 5 Plant in use, crew members and hours worked.
  - 6 Method of boring or drilling, flushing medium and type of drill bit.
  - 7 Type, diameter and depth of casing used.
  - 8 Diameter and depth of hole at the beginning and end of each working day or shift.
  - 9 Grout returns to surface.
  - 10 Loss of any flushing medium during drilling.
  - 11 Standing time, with reason, or time lost overcoming obstructions.
  - 12 Details of underground services located.
  - 13 Details of any settlement or ground heave.
  - 14 Daily and cumulative length drilled.
  - 15 Depth to each major change of stratum.
  - 16 Description, with identification, of the stratum and whether it is intact or broken.

- 17 Each depth at which groundwater is encountered (if apparent), the depth to which it rose and any steps taken to stop the flow.
- 18 Depths at which any samples are taken.
- 19 Details of any voids or suspected workings.
- 20 Details of any emissions of gas, water, etc.
- 21 Depth of completed borehole.

10.8 Daily Grouting Records shall be provided for each borehole and contain the following information:

- 1 Job title and location.
- 2 Hole reference number.
- 3 Date.
- 4 Contractor's name.
- 5 Plant in use, crew members and hours worked.
- 6 Details of type of injection grout-line dimensions and length of standpipes inserted (e.g. tremie injection through 25 mm diameter line).
- 7 Type of grout mix and volumetric quantity injected including total quantity by weight by each type of grouting material introduced.
- 8 Grout pressures recorded, with the corresponding depths.
- 9 The results of all flow and bleed tests.
- 10 Details of casing abandoned.
- 11 Completion status of the grouting operation.
- 12 Details of grouting materials delivered to the site and a running total of each of the materials delivered.
- 13 The nature, frequency and results of all inspections of services to check for grout penetration.
- 14 Details of all stoppages or delays and any other relevant information.

10.9 The daily records of materials and plant received shall show in particular that day's quantities by weight of each type of material and cumulative quantities. With the daily records, the WC shall submit to the MC copies of receipts or invoices for all materials delivered and shall keep them on site until the Works are complete.

10.10 Notwithstanding the information listed above, the WC shall provide any other information required by the MC or the Engineer.

10.11 On completion of the drill and grout programme, the WC shall prepare a validation report containing copies of borehole records, a borehole location plan, as-built co-ordinates and elevations of the grout holes, procedures followed during the works, the results of validation boreholes and pressure tests, a record of any deviation from this Specification and groundwater monitoring data as required by the EA. The validation report shall be prepared and presented in a timely manner on completion of the works (within 4 weeks of completion).

## 11 Treatment of Mine Entries

### General

- 11.1 No mine entries are recorded onsite on Coal Authority records. However, it is possible that unrecorded mine entries could be present. Bell pits or adits are not envisaged to be present due to the thickness of the superficial deposits and depth to coal. If potential unrecorded mineshafts are identified, investigation and treatment shall be treated in accordance with CIRIA C758D and as follows. (Note: investigation to be carried out by the MC as required).

### Treatment of Mineshafts

- 11.2 Should any unrecorded/unforeseen mine entries be encountered, all plant and equipment should cease operation and be moved to a safe distance from the potential collapse zone. The Coal Authority should be contacted and any mineshaft treatment/capping be agreed and authorised by the Coal Authority.

## 12 Special Requirements

### Programme / Sequence of Works

- 12.1 The site will be an active construction site where earthworks operations and other construction activities may be taking place. The WC shall need to co-ordinate the grouting operations with the MC and the earthworks sub-contractor. The Sequence of Works presented herein (Section 7, Paragraph 7.13) is advised based on the MC's advice of optimum benefit. Notwithstanding this, the progression of grouting from the down dip side should always be maintained irrespective of commencement from some other point advised by the MC.

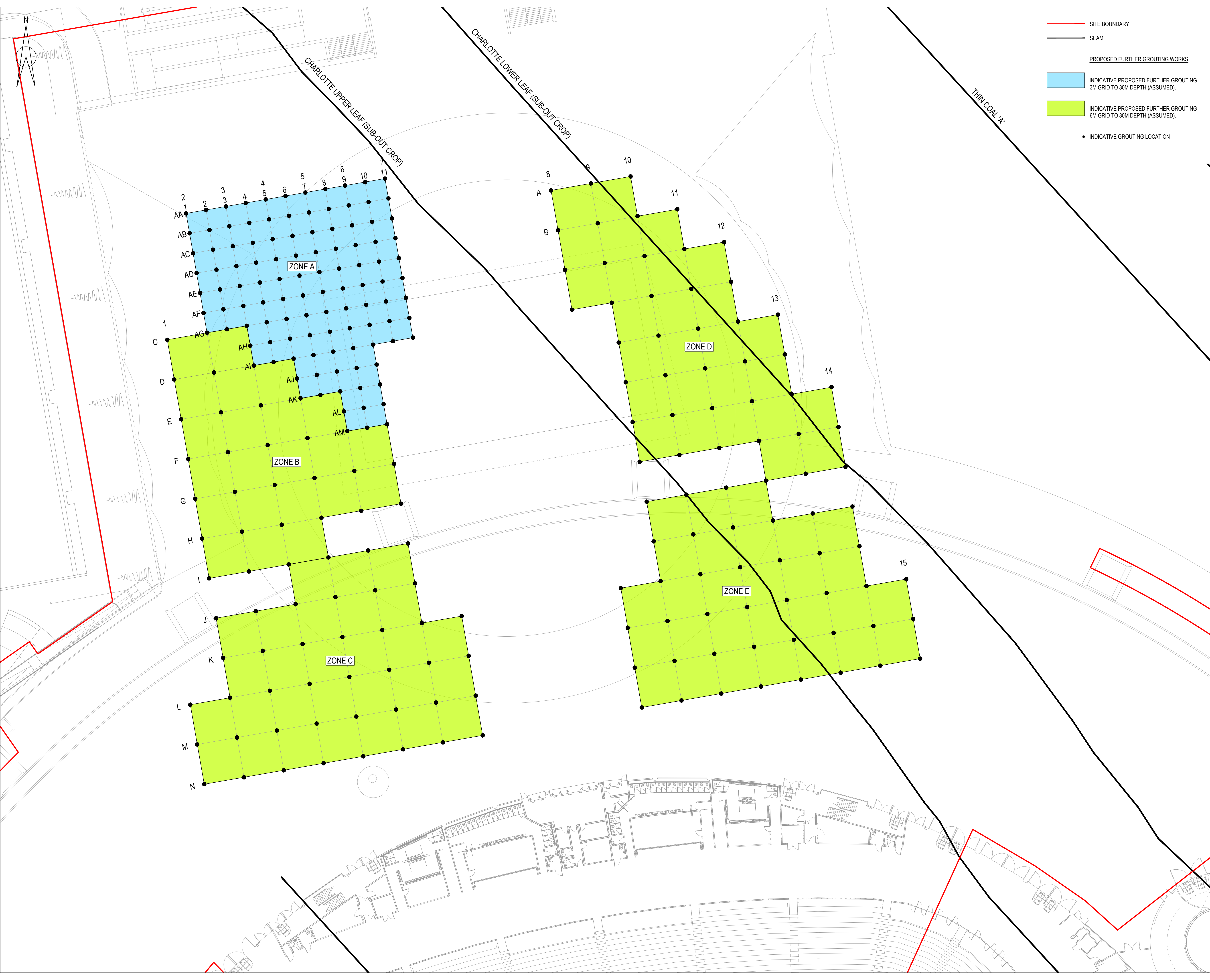
### Existing Backstays supporting existing roof.

- 12.2 Work is required in close proximity to the existing backstay foundations which are tension foundations for the stadium roof structure. these are a critical part of the existing structure and the grouting designer will need to take account of these historic foundations and anchor designs and their associated zones of influence in their grouting proposals. Based on the available historic information, it is understood that the ground anchors are installed to a nominal 2.5 degrees from the vertical (as built records contained in the City of Manchester Stadium Health and Safety Files, Volume B13B and B13C). With regards to the grouting works, it is assumed that the pressure under which the grout is placed will not be sufficient to cause any displacement to the existing anchors. On this basis the recommended exclusion zone around each anchor for the grouting works is 1m radially around the centre of the anchor. The grouting contractor is responsible for reviewing their drilling tolerances and the as built records to ensure that this exclusion zone is complied with.

### Environment Agency

- 12.3 Special monitoring requirements are required by the Environment Agency - details of which are provided in Clauses 8.20 to 8.27 herein.

**Appendix A Indicative Proposed Grouting Plan**



- SITE BOUNDARY
- SEAM
- PROPOSED FURTHER GROUTING WORKS
- INDICATIVE PROPOSED FURTHER GROUTING  
3M GRID TO 30M DEPTH (ASSUMED).
- INDICATIVE PROPOSED FURTHER GROUTING  
6M GRID TO 30M DEPTH (ASSUMED).
- INDICATIVE GROUTING LOCATION

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DO NOT SCALE THIS DRAWING.

HEALTH AND SAFETY INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING CONSTRUCTION.

MAINTENANCE/CLEANING/OPERATION.

DECOMMISSIONING/DEMOLITION.

Notes

1.

REF. ARUP, COAL SEAMS AND SHAFT LOCATIONS, DRAWING NO. ARP-LAY-CG-130, REVISION C, 01.03.2010.

2.

UTILITIES & EASEMENTS ARE NOT SHOWN ON THIS DRAWING. FOR SERVICES LOCATIONS SEE BURO HAPPOLD DRAWING NO. MNS-BHE-XX-XX-DR-CV-9101, COMBINED UTILITIES, REVISION P01, 08.09.22.

3.

INDICATIVE GROUTING ZONES BASED ON THE PROPOSED LAYOUTS AS INDICATED ON THE POPULOUS DRAWING NSE-POP-ZZ-ZZ-DR-A-009100.

4.

THE INDICATIVE PROPOSED GROUTING AREAS ARE A DESIGN INTENT.

5.

THE ENVISAGED WORKS CONSIST OF THE DRILLING AND GROUTING OF SHALLOW MINE WORKINGS AND ANY ASSOCIATED FRACTURED OR BROKEN GROUND WITHIN THE AREA GENERALLY INDICATED. AT THIS STAGE, THE FOUNDATION DESIGN INTENT ASSUMES A MAXIMUM PILE LENGTH OF 27 M. THIS WILL BE SUBJECT TO DETAILED DESIGN BY THE SPECIALIST PILING CONTRACTOR.

6.

WORK IS REQUIRED IN CLOSE PROXIMITY TO THE EXISTING BACKSTAY FOUNDATIONS WHICH ARE TENSION FOUNDATIONS FOR THE STADIUM ROOF STRUCTURE. THESE ARE A CRITICAL PART OF THE EXISTING STRUCTURE AND THE GROUTING DESIGNER WILL NEED TO TAKE ACCOUNT OF THESE HISTORIC FOUNDATIONS AND ANCHOR DESIGNS AND THEIR ASSOCIATED ZONES OF INFLUENCE IN THEIR GROUTING PROPOSALS. PROPOSED GROUTING WORKS IN THESE LOCALISED AREAS WILL NEED TO BE DISCUSSED DURING THE WORKS CONTRACTORS DETAILED DESIGN STAGE TO ENSURE THAT THEIR DESIGN AND METHODOLOGIES DO NOT COMPROMISE THE STABILITY AND INTEGRITY OF THESE STRUCTURES DURING THE GROUTING WORKS.

P02 UPDATED SITE BOUNDARY. ISSUED FOR INFORMATION

P01 INFORMATION

Rev

Description

Date

Dm

Cr'd

31.03.23

NG

CO

14.03.23

NG

CO

INFORMATION

Status of drawing

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Architect

Project

Drg Title

ETIHAD CAMPUS SITE IMPROVEMENT WORKS  
INDICATIVE PROPOSED  
GROUTING AREAS

Scales@A1 1:250  
Drawn by NG  
Checked by CO

Job No. 0053810  
Date MAR 2023  
Rev P02

Drawing No. NSE-BHE-XX-XX-DR-CG-001007



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