

**Willmott Dixon**

**BISHOP HEDLEY SCHOOL, MERTHYR TYDFIL  
(NORTHERN CAMPUS AND SPORTS PITCH)**

**Earthworks Validation Report**

14075/JJ/26/VR

**CLIENT:** Willmott Dixon

**PROJECT:** Bishop Hedley School, Merthyr Tydfil  
(Northern Campus and Sports Pitch)

**TITLE:** Earthworks Validation Report

**JOB NO:** 14075

**DOCUMENT REF:** 14075/JJ/26/VR

| Revision | Purpose Description | Originated | Reviewed | Authorised | Date      |
|----------|---------------------|------------|----------|------------|-----------|
| 0        | Issue               | JJ         | RB       | RB         | July 2026 |

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## **1.0 INTRODUCTION**

### **1.1 GENERAL**

Willmott Dixon is redeveloping a site located off Galon Uchaf Road, Merthyr Tydfil, for educational and sports pitch end-use.

The site comprises the existing Bishop Hedley School Campus – Northern Campus (to the east of Galon Uchaf Road) and part of Galon Uchaf Park (to the west of Galon Uchaf Road).

The location of the site is shown in Figure 1. A site plan is presented in Figure 2.

Earthworks have been undertaken across the site as part of the redevelopment. Intégral Géotechnique (Wales) Limited were commissioned by Willmott Dixon to undertake monitoring and validation of the engineered earthworks, including observation of fill placement and compaction together with geotechnical and chemical verification testing, generally in accordance with the Earthworks Specification prepared by Intégral Géotechnique (Wales) Limited (Reference BCA-IGW-XX-XX-RP-G-0007-S2-P01, March 2024).

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### **1.2 PROPOSED DEVELOPMENT**

The redevelopment proposals comprise the demolition of the existing school buildings on the Northern Campus, followed by the construction of a new school building with associated access roads and car parking areas.

In addition, a new sports pitch is proposed on part of the existing Galon Uchaf Park, situated to the west of Galon Uchaf Road. The formation of the sports pitch, associated access track and embankment required the placement of engineered fill materials to achieve the proposed finished development levels.

## **1.2 PROPOSED DEVELOPMENT** (CONTINUED)

The earthworks comprised cut and fill operations across the Northern Campus to create level development plateaux, with foundations for the proposed school buildings extending through any engineered fill into the underlying competent natural ground.

Ground stabilisation works associated with shallow ironstone workings and a recorded mine shaft were also undertaken on the Northern Campus. These specialist works were designed, supervised and certified by others and therefore fall outside the scope of this report.

Minor localised filling works were also undertaken on the Northern Campus to achieve finished formation levels behind proposed retaining structures.

The principal filling works were undertaken within the Western Playing Field to the west of Galon Uchaf Road, where engineered fill was placed to form the proposed sports pitch, access track and associated embankment. Cut and fill analysis drawings, prepared by Cambria Consulting Limited, are presented in Appendix A.

The Earthworks Specification for the proposed development is referenced BCA-IGW-XX-XX-RP-G-0007-S2-P01, dated March 2024, and required the earthworks to be undertaken in accordance with the Department for Transport Specification for Highway Works.

This report presents the findings of the earthworks monitoring and validation programme undertaken by Intégral Géotechnique (Wales) Limited and summarises the results of geotechnical and chemical verification testing completed during the works. This report relates solely to validated engineered fill areas within the Northern Campus and the Western Playing Field sports pitch. The Southern Campus was not subject to earthworks under this contract and is therefore excluded from the scope of this report.

## **2.0 BACKGROUND**

### **2.1 SITE LOCATION AND DESCRIPTION**

The site is located off Galon Uchaf Road, approximately 1km northeast of Merthyr Tydfil town centre, at National Grid Reference 305350, 207380. The location of the site is shown in Figure 1. A site plan is presented in Figure 2.

The site comprises two distinct areas separated by Galon Uchaf Road.

The existing Bishop Hedley School Campus is situated to the east of Galon Uchaf Road. The campus is divided by Gwaunfarren Road into two separate parts: the Northern Campus, situated to the north of Gwaunfarren Road, upon which the new school building is being constructed; and the Southern Campus, situated to the south of Gwaunfarren Road.

The Northern Campus is bounded by Galon Uchaf Road to the northwest, allotment gardens and residential development to the east, and residential development to the north. The Northern Campus and Southern Campus are linked by an existing pedestrian tunnel beneath Gwaunfarren Road. The Southern Campus is not subject to earthworks under this contract and is excluded from the scope of this report.

The Northern Campus is situated on sloping ground that generally falls to the south, with elevations ranging from approximately 275m AOD in the north to approximately 265m AOD at the Gwaunfarren Road boundary.

The Western Playing Field is situated to the west of Galon Uchaf Road and forms part of the existing Galon Uchaf Park. The area is bounded by Galon Uchaf Road and existing residential properties to the east, undeveloped land with residential development beyond to the south, undeveloped woodland to the west, and existing sports pitches to the north. The ground generally slopes to the south, with elevations ranging from approximately 278m AOD in the north to approximately 270m AOD in the south. Prior to the earthworks, the area comprised undeveloped public open space with two existing level plateaux, referred to as Plateau 1 (southern) and Plateau 2 (northern), separated by an intervening embankment.

## 2.2 AVAILABLE SITE INVESTIGATION DATA

The following reports, prepared by Intégral Géotechnique (Wales) Limited, have been reviewed in the preparation of this report:

- Site Investigation Report, Bishop Hedley School Campus, Merthyr Tydfil, referenced BCA-IGW-XX-XX-RP-G-0001-S2-P04, dated January 2024, prepared for Willmott Dixon.
- Proposed Sports Pitch and Access Track, Bishop Hedley School, Merthyr Tydfil – Supplemental Geotechnical Ground Investigation and Settlement Assessment Report, referenced BCA-IGW-XX-XX-RP-G-0004-S2-P01, dated January 2024, prepared for Willmott Dixon Construction Limited.
- Outline Remediation Strategy Report, Bishop Hedley School Campus, Merthyr Tydfil, referenced BCA-IGW-XX-XX-RP-G-0007-S2-P02, dated February 2024, prepared for Willmott Dixon Construction Limited.
- Mining Risk Assessment Report, Bishop Hedley School (Northern Campus), Merthyr Tydfil, referenced BCA-IGW-XX-XX-RP-G-0008-S2-P01, dated June 2024, prepared for Willmott Dixon Construction Limited.

Reference should be made to the above reports for full details of the site investigation works undertaken and the ground conditions encountered.

## 2.3 SITE HISTORY

The following summary is based on a review of historical Ordnance Survey mapping and aerial photography considered as part of the previous site investigation works as detailed in the reports listed in Section 2.2 above.

The earliest available mapping, dated 1875, indicates the site to have been undeveloped agricultural land. Features of note in the vicinity included a coal shaft approximately 50m to the east of the northern campus area, an air shaft approximately 20m to the east, and an old level approximately 80m to the southeast. An embankment with an associated railway track, likely related to coal and ironstone extraction, ran along the northern and northwestern boundary of the site. Pen-y-Darren Iron Works was operational approximately 250m to the south, with extensive patch workings noted in the wider area. A surface water feature ran along the eastern boundary of the site.

## **2.3 SITE HISTORY (CONTINUED)**

The area to the west of Galon Uchaf Road contained areas of disturbed ground from the earliest mapping. Historical mapping dated 1885 shows evidence of large-scale excavation associated with historical surface mining operations across the area now forming Plateau 2, with an area of disturbed ground interpreted as a former spoil heap within the southern area now forming Plateau 1. By the 1963–1964 edition, the disturbed ground was confirmed as refuse tips. By 1967, evidence of significant landfilling works was present across the western playing field area, with embankment slopes formed along the southern and western boundaries. Mapping dated 1975 shows extensive site reprofiling earthworks, with formation of Plateau 1 and Plateau 2, indicating that landfilling operations had ceased by that time.

Historical mapping from the period 1957–1989 indicates Bishop Hedley Roman Catholic High School to have been constructed within the eastern area of the site, with the northern campus buildings understood to have been erected in 1967. Earthworks were undertaken to create level development plateaux for the school buildings and associated areas. The school campus and the western playing fields remained substantially unchanged from the 1990s to the present day.

## **2.4 GROUND CONDITIONS SUMMARY**

The following summary is based on the previous site investigation works, as detailed in the reports listed in Section 2.2 above.

### **2.4.1 Northern Campus**

Beneath the Northern Campus, ground conditions typically comprised a variable thickness of made ground and reworked ground overlying natural in-situ glacial till deposits. Bedrock was proven at depths of between approximately 5.m and 16.1m below ground level.

In areas of soft landscaping, topsoil was encountered to typically 0.1–0.4m depth. Areas of hardstanding typically comprised tarmac or bituminous material to typically 0.10m depth over granular sub-base.

Made ground and reworked ground was encountered across the majority of the Northern Campus to depths of between approximately 0.50m and 4.0m below existing ground level. The reworked ground materials comprised natural soils cut and placed as fill during historical earthworks. Locally, made ground containing anthropogenic materials including slag, concrete, plastic, glass and wood was present overlying the reworked materials.

## **2.4 GROUND CONDITIONS SUMMARY (CONTINUED)**

Natural glacial till was encountered from typically 0.2–2.3m depth and proven to greater than 2.0–4.8m depth. The glacial till generally comprised firm to stiff, brownish grey to reddish brown, sandy gravelly clay with low to high cobble and boulder contents of angular to sub-rounded sandstone, siltstone and mudstone.

Shallow abandoned ironstone mine workings were encountered in 11 of 25 rotary boreholes drilled across the site at depths of between approximately 18.2m and 32.5m below ground level. Evidence of voids of up to 2.9m combined height was recorded. A Mining Remediation Authority recorded mine shaft (Shaft 305207-009), approximately 2.5m in diameter and 14m deep, was located at 305400.77E, 207454.23N. Drilling and grouting ground stabilisation works and shaft treatment have been undertaken and certified by others, and these works fall outside the scope of this report.

### **2.4.2 Western Playing Field**

Beneath the Western Playing Field, ground conditions are characterised by a thin veneer of topsoil, typically 0.10–0.20m thick, underlain by variable made ground comprising domestic refuse and landfill waste deposited during the 1960s and 1970s. The landfill waste typically consists of very loose to loose dark grey to black slightly silty very sandy gravel of ash, clinker, burnt shale and slag, with frequent glass, metal, timber, brick and plastic waste materials.

The base of the landfill waste was not proven in the majority of exploratory holes, with boreholes terminated at depths of up to 8.0m below existing ground level. Natural glacial till was locally encountered in selected exploratory locations at depths of between 1.0m and 2.7m below existing ground level. Weathered mudstone bedrock was encountered in two boreholes at depths of 7.0m and 10.5m below ground level.

Settlement modelling undertaken as part of the settlement assessment referenced in Section 2.2 indicates that residual long-term creep settlements of 270–530mm over a 60-year design life are predicted beneath the sports pitch, and 230–460mm beneath the access track embankment. Immediate and consolidation settlements of up to approximately 110mm are also predicted, anticipated to occur largely during fill placement given the high permeability of the landfill waste.

### **2.4.3 Groundwater**

Groundwater was encountered at variable depths across both site areas during the intrusive investigation.

## **2.4 GROUND CONDITIONS SUMMARY (CONTINUED)**

Within the Northern Campus, groundwater levels recorded during monitoring ranged from 0.41m to 3.75m below ground level across standpipe locations.

Within the Western Playing Field, groundwater monitoring standpipes installed in the landfill area were recorded as dry during all monitoring visits.

Groundwater conditions may vary seasonally, and reference should be made to the site investigation reports in Section 2.2 for full monitoring data.

## **2.5 PREVIOUSLY IDENTIFIED CONTAMINATION**

Site investigation works identified elevated concentrations of contaminants within the made ground across both the Northern Campus and the Western Playing Field. The Suitable 4 Use Levels (S4ULs) published by LQM were adopted as the principal assessment criteria against which soil contaminant concentrations were compared. In the absence of published S4ULs for individual contaminants, the Category 4 Screening Levels (C4SLs) published by DEFRA and Soil Screening Values (SSVs) derived by Atkins ATRISKsoil for a residential end use without consumption of homegrown produce were adopted, where considered appropriate.

Published assessment criteria for a school end use are not available. A residential end use without consumption of homegrown produce was therefore adopted as a conservative assessment basis in the first instance.

Within the made ground on the Northern Campus, locally elevated concentrations of beryllium and polycyclic aromatic hydrocarbons (PAHs), including benzo(a)pyrene, benzo(b)fluoranthene and dibenzo(ah)anthracene, were identified. Asbestos was not detected in screened samples from this area; however, given the age of the school buildings, the presence of asbestos containing materials associated with buried structures, services and drainage runs was considered reasonably anticipated. Post-demolition inspection and handpicking of exposed formations for asbestos containing materials has been undertaken in accordance with the remediation strategy referenced in Section 2.2.

Within the made ground and landfill materials on the Western Playing Field, elevated concentrations of beryllium, arsenic and PAH compounds were identified. Asbestos fibres identified as loose chrysotile were detected within a made ground sample from windowless sample borehole WS11 at 0.6m depth, at a concentration of less than 0.001% by weight.

**2.5 PREVIOUSLY IDENTIFIED CONTAMINATION** (CONTINUED)

Suspected asbestos containing material was also identified at trial pits TP15 and TP17. Laboratory testing confirmed the material from TP15 to comprise chrysotile hard/cement type material, whilst no asbestos was detected in the sample from TP17.

### **3.0 EARTHWORKS METHODOLOGY**

#### **3.1 NORTHERN CAMPUS FILL AREAS**

Earthworks on the Northern Campus principally comprised cut operations to reduce existing ground levels and create development plateaux for the proposed school buildings and associated infrastructure. Building foundations extend through any engineered fill into the underlying natural ground.

During cut operations, historical made ground was stripped and excavated separately from the underlying natural glacial till.

Made ground was removed from beneath proposed landscaped areas, in accordance with the remediation strategy referenced in Section 2.2 and was not re-used as fill within these areas. Processed made ground was instead re-used as engineered fill beneath hardstanding and building footprint areas on the Northern Campus and transported to the Western Playing Field for re-use as engineered fill beneath the sports pitch and access track, as described in Section 5.1.

Natural glacial till was re-used within proposed landscaped areas of the Northern Campus where finished levels necessitated filling. Processed till was also transported to the Western Playing Field, for re-use as engineered fill beneath the sports pitch and access track.

Localised filling works were undertaken behind retaining structures and in isolated low-lying areas to achieve the required finished formation levels. Fill depths and extents within these areas are generally limited.

Prior to fill placement, reduced formation levels were proof rolled. Localised soft spots identified during proof rolling were excavated and replaced with suitable engineered fill. Fill was then placed and compacted in layers not exceeding 250mm loose thickness until the required formation levels were achieved.

Site photographs recording the earthworks are presented in Appendix B.

#### **3.2 SPORTS PITCH**

The sports pitch is located within the Western Playing Field to the west of Galon Uchaf Road. Prior to the earthworks, the site comprised two development plateaux, referred to as Plateau 1 and Plateau 2, separated by an existing embankment.

### **3.2 SPORTS PITCH** (CONTINUED)

The earthworks comprised the stripping of topsoil, followed by the placement of engineered fill to raise existing ground levels and create the proposed sports pitch on Plateau 2, together with the associated access track embankment extending across Plateau 1. The engineered fill comprised processed made ground and glacial till arisings from the Northern Campus cut operations, as described in Section 3.1. The existing landfill waste and made ground encountered within the Western Playing Field were retained in situ beneath the placed engineered fill and were not re-used as fill material.

Fill depths range from approximately 0.50m to 2.50m beneath the sports pitch and from approximately 0.50m to 3.50m beneath the access track embankment. The greatest fill depths occur where the former embankment between Plateau 1 and Plateau 2 was raised and extended.

Prior to fill placement, the existing ground surface was prepared in accordance with the Earthworks Specification. Engineered fill was then placed and compacted in layers not exceeding 250mm loose thickness until the required formation levels were achieved.

The Earthworks Specification recommended the incorporation of geogrid reinforcement beneath the proposed sports pitch and access track, to assist in distributing applied loads and reducing the effects of long-term residual and creep settlement within the underlying landfill deposits.

Site photographs recording the earthworks are presented in Appendix B.

Following completion of the earthworks, the specialist sports pitch construction was completed by others in accordance with the approved sports pitch design. The sports pitch construction design drawings (showing the pitch make-up and drainage details – including the presence of an impermeable membrane and geogrid) is presented in Appendix C.

## 4.0 EARTHWORKS VERIFICATION – NORTHERN CAMPUS

### 4.1 EARTHWORKS PLACEMENT

The Northern Campus earthworks comprised predominantly cut operations, with localised areas of engineered fill placed behind retaining structures and within isolated low-lying areas to achieve the required finished formation levels.

During cut operations, historical made ground was stripped and excavated separately from the underlying natural glacial till, in accordance with the methodology described in Section 3.1. The arisings were assessed for suitability for re-use as engineered fill in accordance with the Earthworks Specification.

Prior to fill placement, reduced formation levels were proof rolled. Localised soft spots identified during proof rolling were excavated and replaced with suitable compacted engineered fill.

Engineered fill was placed and compacted in layers not exceeding 250mm loose thickness. Validation testing was undertaken throughout the earthworks to confirm compliance with the Earthworks Specification. The results of the validation testing are presented in Sections 4.3 and 4.4.

### 4.2 LABORATORY GEOTECHNICAL TESTING AND MATERIAL CLASSIFICATION

Representative bulk samples of the processed cut arisings were recovered during the earthworks and submitted to the laboratories of GSTL for classification testing. The processed material comprised reworked glacial till for re-use as engineered fill across both the Northern Campus and the Western Playing Field sports pitch earthworks.

Testing comprised natural moisture content determination, Atterberg Limits and particle size distribution. The laboratory test results are presented in Appendix D and summarised in Table 1 below.

| Table 1: Summary of Laboratory Classification Test Results |                                      |        |        |        |        |                   |           |
|------------------------------------------------------------|--------------------------------------|--------|--------|--------|--------|-------------------|-----------|
| Sample                                                     | Description                          | MC (%) | LL (%) | PL (%) | PI (%) | % passing 0.425mm | SHW Class |
| B1                                                         | Brown/grey sandy gravelly silty CLAY | 10     | 34     | 9      | 25     | 62                | 2C        |
| B2                                                         | Grey brown gravelly sandy silty CLAY | 11     | 27     | 9      | 18     | 71                | 2A/2B     |
| B3                                                         | Grey silty fine to coarse GRAVEL     | 10     | 40     | 9      | 31     | 39                | 2C        |
| B4                                                         | Grey sandy gravelly silty CLAY       | 13     | 37     | 12     | 25     | 55                | 2C        |
| B5                                                         | Grey sandy silty clayey GRAVEL       | 9.3    | 34     | 9      | 25     | 34                | 2C        |

## 4.2 LABORATORY GEOTECHNICAL TESTING AND MATERIAL CLASSIFICATION (CONTINUED)

Four of the five samples classify as Class 2C and one sample (B2) as Class 2A/2B in accordance with Table 6/2 of Series 600 of the Specification for Highway Works. Both classifications are acceptable for use as engineered fill under the Earthworks Specification. No sample exceeds the specified liquid limit or plasticity index acceptance criteria.

The laboratory classification testing demonstrates that the processed cut arisings consistently comprised acceptable Series 600 engineered fill suitable for re-use within the proposed earthworks.

## 4.3 IN SITU VERIFICATION TESTING

In situ verification testing of the Northern Campus fill areas comprised plate load testing during fill placement, together with windowless sample boreholes incorporating Continuous SPT Probing to verify the completed fill profile. Validation test locations are shown in Figure 3.

### 4.3.1 Plate Load Testing

Ten plate load tests (PT1 to PT10) were undertaken by South Wales Ground Testing (SWGT) during June 2024 using a 600mm diameter circular steel plate. Load was applied using a hydraulic jack reacting against a tracked excavator, with settlement measured by three dial gauges mounted on independent datum beams. The plate load test records are presented in Appendix E.

Tests PT1 to PT4, PT9 and PT10 were undertaken following placement of approximately 1.0m of engineered fill. Tests PT5 to PT8 were undertaken following placement of approximately 2.0m of engineered fill. The results are summarised in Table 2 below.

| Table 2: Summary of Plate Load Test Results – Northern Campus Fill Areas |          |            |                                           |                 |
|--------------------------------------------------------------------------|----------|------------|-------------------------------------------|-----------------|
| Test                                                                     | Date     | Fill depth | Settlement @<br>150kN/m <sup>2</sup> (mm) | Approx. CBR (%) |
| PT1                                                                      | 12.06.24 | 1m         | 7.70                                      | 3.71            |
| PT2                                                                      | 12.06.24 | 1m         | 5.83                                      | 5.31            |
| PT3                                                                      | 12.06.24 | 1m         | 2.61                                      | 14.90           |
| PT4                                                                      | 12.06.24 | 1m         | 11.94                                     | 2.11            |
| PT5                                                                      | 20.06.24 | 2m         | 8.62                                      | 3.21            |
| PT6                                                                      | 20.06.24 | 2m         | 8.19                                      | 3.43            |
| PT7                                                                      | 20.06.24 | 2m         | 7.66                                      | 3.74            |
| PT8                                                                      | 20.06.24 | 2m         | 6.27                                      | 4.83            |
| PT9                                                                      | 25.06.24 | 1m         | 2.08                                      | 19.94           |
| PT10                                                                     | 25.06.24 | 1m         | 2.57                                      | 15.19           |

### 4.3 IN SITU VERIFICATION TESTING (CONTINUED)

Nine of the ten plate load tests returned calculated CBR values of 3% or greater together with acceptable settlements under the maximum applied pressure of 150kN/m<sup>2</sup>. Plate Load Test PT4 returned a marginal result, with a calculated CBR of approximately 2.1% and settlement of 11.94mm.

The marginal result at PT4 was attributed to a localised soft area within the fill. The affected material was excavated and replaced with suitable engineered fill prior to completion of the earthworks. The area was subsequently included within the Continuous SPT Probing verification undertaken following completion of the earthworks.

#### 4.3.2 Windowless Sampling and Continuous SPT Probing

Six windowless sample boreholes (WSA to WSF) and six Continuous SPT Probes (CPT A to CPT F) were undertaken by South Wales Ground Testing (SWGTT) following completion of the Northern Campus earthworks. The works were undertaken using a Dart 554 windowless sampling rig. The Continuous SPT Probing was undertaken using SPT rods fitted with a solid cone in place of a split-spoon sampler, providing a continuous SPT N-equivalent profile with depth.

The windowless sample logs are presented in Appendix F. The continuous SPT probing results are presented in Appendix G.

The windowless sample boreholes were advanced to recover representative samples of the placed engineered fill for laboratory chemical testing. The boreholes confirmed the engineered fill generally comprised firm to stiff sandy gravelly clay with a low cobble content, consistent with the processed site-won materials placed during the earthworks.

Continuous SPT Probing was undertaken at adjacent locations to assess the density of the engineered fill throughout the completed fill profile. The results are summarised in Table 3 below.

| <b>Table 3: Summary of Continuous SPT Results – Northern Campus Fill Areas</b> |                           |                          |                           |                        |
|--------------------------------------------------------------------------------|---------------------------|--------------------------|---------------------------|------------------------|
| <b>Hole</b>                                                                    | <b>Fill Thickness (m)</b> | <b>Depth reached (m)</b> | <b>Terminal condition</b> | <b>Typical N range</b> |
| CPT A                                                                          | 3.00                      | 4.67                     | Refusal 50/170mm          | 10–29                  |
| CPT B                                                                          | 2.40                      | 3.77                     | Refusal 50/170mm          | 14–35                  |
| CPT C                                                                          | 2.00                      | 4.18                     | Refusal 50/275mm          | 8–43                   |
| CPT D                                                                          | 2.00                      | 3.90                     | No refusal                | 9–36                   |
| CPT E                                                                          | 2.00                      | 5.10                     | No refusal                | 10–42                  |
| CPT F                                                                          | 1.50                      | 4.14                     | Refusal 50/235mm          | 9–39                   |

#### **4.3 IN SITU VERIFICATION TESTING (CONTINUED)**

All six Continuous SPT Probes penetrated through the engineered fill and terminated within the underlying glacial till. N values within the engineered fill generally range between 10 and 35, with localised higher values recorded towards the base of the fill profile consistent with the transition into the underlying natural glacial till.

The Continuous SPT Probing results demonstrate that the engineered fill has been placed consistently and is well compacted throughout the validated fill profile.

#### **4.4 CHEMICAL VALIDATION TESTING**

Representative soil samples were recovered from the placed engineered fill within the Northern Campus and submitted to the UKAS accredited laboratories of i2 Analytical for laboratory chemical testing.

Testing comprised metals and semi-metals, inorganic chemicals, polycyclic aromatic hydrocarbons (PAHs) and asbestos.

The sample locations are shown in Figure 3. The laboratory certificates are presented in Appendix J. A summary of the analytical results together with the screening assessment is presented in Appendix K.

The Suitable 4 Use Levels (S4ULs) published by LQM have been adopted as the principal assessment criteria against which soil contaminant concentrations have been compared. In the absence of published S4ULs for individual contaminants, the Category 4 Screening Levels (C4SLs) published by DEFRA and Soil Screening Values (SSVs) derived by Atkins ATRISKsoil have been adopted where considered appropriate.

The analytical results demonstrate that all samples comply with the adopted assessment criteria. No exceedances of the applicable screening criteria were identified for metals, inorganic chemicals or PAHs. Asbestos was not detected in any of the samples tested.

The chemical validation testing confirms that the placed engineered fill within the Northern Campus is suitable for its intended end use from a geoenvironmental perspective.

#### **4.5 VALIDATION SUMMARY**

Laboratory geotechnical testing confirmed that the processed site-won materials comprised SHW Class 2C and Class 2A/2B engineered fill in accordance with Series 600 of the Specification for Highway Works. Both material classifications are acceptable for use as engineered fill under the project Earthworks Specification.

Chemical validation testing undertaken on representative samples recovered from the placed engineered fill confirmed compliance with the adopted assessment criteria for the proposed end use. No exceedances of the adopted screening criteria were identified, and asbestos was not detected in any of the samples tested.

Plate load testing undertaken during construction demonstrated satisfactory performance of the engineered fill during placement. One localised soft area was identified during testing at Plate Load Test PT4. The affected material was excavated and replaced with suitable engineered fill prior to completion of the earthworks.

Windowless sample boreholes confirmed the placed material to comprise firm to stiff engineered fill consistent with the processed site-won materials used during the earthworks. Continuous SPT Probing demonstrated consistent penetration resistance throughout the engineered fill profile, with all probes extending through the placed fill and terminating within the underlying glacial till.

Taken together, the laboratory geotechnical testing, chemical validation testing and in-situ verification testing provide a consistent body of evidence demonstrating that the Northern Campus engineered fill has been placed and compacted in general accordance with the requirements of the Earthworks Specification (Reference BCA-IGW-XX-XX-RP-G-0007-S2-P01).

## **5.0 EARTHWORKS VERIFICATION – SPORTS PITCH**

### **5.1 EARTHWORKS PLACEMENT**

The principal earthworks associated with the proposed development comprised the formation of the new sports pitch and associated access track within the Western Playing Field.

Engineered fill was placed to raise existing ground levels and create the proposed sports pitch platform together with the associated access track embankment. Fill depths range from approximately 0.5m to 2.5m beneath the sports pitch and from approximately 0.5m to 3.5m beneath the access track embankment, with the greatest fill depths occurring across the former embankment separating Plateau 1 and Plateau 2.

The engineered fill comprised processed made ground and glacial till arisings from the Northern Campus cut operations, in accordance with the methodology described in Section 3.2. The existing landfill waste and made ground encountered within the Western Playing Field were retained in situ beneath the placed engineered fill and were not re-used as fill material. Suitable material was placed and compacted in layers not exceeding 250mm loose thickness until the required formation levels were achieved.

Following completion of the earthworks, the specialist sports pitch construction was completed by others in accordance with the approved sports pitch design. Windowless sample boreholes undertaken as part of the validation programme confirmed the completed construction generally comprised approximately 300mm of pitch make-up soils overlying a geotextile separation membrane and the underlying engineered fill.

### **5.2 LABORATORY GEOTECHNICAL TESTING AND MATERIAL CLASSIFICATION**

The engineered fill placed beneath the sports pitch comprised made ground and glacial till processed and classified during the Northern Campus cut operations, as described in Sections 3.1 and 3.2. Laboratory classification testing of this material is presented in Section 4.2 and is not repeated here.

The testing confirmed the materials comprised SHW Class 2C and Class 2A/2B engineered fill in accordance with Series 600 of the Specification for Highway Works. Both classifications are suitable for use as engineered fill under the project Earthworks Specification, and this classification therefore applies equally to the engineered fill placed beneath the sports pitch.

### **5.3 IN SITU VERIFICATION TESTING**

In-situ verification testing of the completed sports pitch comprised windowless sampling, Continuous SPT Probing, Dynamic Cone Penetrometer (DCP) testing and Light Weight Deflectometer (LWD) testing. The validation testing was undertaken across the completed sports pitch and access track to verify the completed construction, assess the consistency and compaction of the underlying engineered fill, and confirm the performance of the completed platform. Validation test locations are shown on Figure 4.

#### **5.3.1 Windowless Sampling**

Twenty-one windowless sample boreholes, referenced WS01 to WS21, were undertaken across the completed sports pitch and access track. The windowless sample logs are presented in Appendix G.

The windowless sample boreholes confirmed the completed sports pitch construction to generally comprise approximately 300mm of pitch make-up soils overlying a geotextile separation membrane. The pitch make-up typically comprised firm brown sandy slightly gravelly clayey silt over loose reddish brown gravelly sand. The make-up is in accordance with the design drawing shown in Appendix C.

Engineered fill was encountered beneath the geotextile separation membrane. The engineered fill generally comprised firm to stiff dark grey sandy gravelly clay with a low cobble content. Gravel was recorded as angular to sub-rounded fine to coarse limestone and mudstone, with cobbles generally comprising limestone. This material is consistent with the processed site-won materials used during the earthworks.

Locally, historical made ground was encountered beneath the engineered fill, consistent with the known ground model for the Western Playing Field and the historical landfill materials present beneath this part of the site.

Representative soil samples were recovered from both the pitch make-up soils and the underlying engineered fill for laboratory chemical testing, as described in Section 5.4.

#### **5.3.2 Continuous SPT Probing**

Forty-two Continuous SPT Probes, referenced CPT1 to CPT42, were undertaken across the completed sports pitch and access track. The Continuous SPT Probing records are presented in Appendix H.

The probes were undertaken using SPT rods fitted with a cone attachment to provide a continuous penetration resistance profile through the completed construction and underlying engineered fill.

### 5.3 IN SITU VERIFICATION TESTING (CONTINUED)

N values within the engineered fill were generally in the range of approximately 6 to 25, with localised higher values and practical refusals where coarser or denser materials were encountered. The results demonstrate a generally consistent penetration resistance profile through the placed fill.

The Continuous SPT Probing did not identify significant laterally persistent zones of low penetration resistance within the engineered fill. The results demonstrate that the placed fill is generally consistent across the validated sports pitch and access track areas, with locally higher resistance associated with coarser or more densely compacted material.

#### 5.3.3 *Dynamic Cone Penetrometer Testing*

Forty-one DCP tests, referenced TRL1 to TRL42 (TRL38 was not undertaken), were carried out across the completed sports pitch and access track to assess the near-surface strength profile. Calculated CBR values, derived after Webster et al. (1992), are presented in Appendix H.

The upper approximately 300mm of each profile relates to the pitch make-up soils and has been disregarded for the purposes of assessing the underlying engineered fill.

Within the engineered fill, calculated CBR values were variable, commonly ranging from approximately 5% to in excess of 30%, with practical refusal (CBR values at or approaching the instrument's effective ceiling) recorded in just over half of the probes. This is consistent with the cobble content described within the windowless sample logs (Section 5.3.1) and is considered indicative of localised coarser material rather than any weakness within the fill. In several probes, refusal occurred at relatively shallow depth immediately below the pitch make-up (TRL9, TRL22, TRL39, TRL42), consistent with cobble content at or close to the top of the engineered fill.

Two probes (TRL26 and TRL31), located outside the sports pitch footprint, recorded lower calculated CBR values through the tested profile. These are considered localised and are not indicative of a wider zone of weakness.

Overall, the DCP results are consistent with the SPT probing and windowless sample data and confirm that the engineered fill has achieved satisfactory near-surface strength across the validated sports pitch and access track areas.

### 5.3 IN SITU VERIFICATION TESTING (CONTINUED)

#### 5.3.4 *Light Weight Deflectometer Testing*

Twenty-five Light Weight Deflectometer (LWD) tests, referenced LWD1 to LWD25, were undertaken across the completed sports pitch and access track. The LWD test records are presented in Appendix I.

Twenty tests (LWD2–LWD11, LWD16–LWD25) were undertaken within the sports pitch area, following local excavation to a depth of approximately 300mm, seating the test plate directly on the surface of the engineered fill beneath the overlying capping soils. The remaining five tests (LWD1, LWD12–LWD15) were undertaken at ground level on the access track formation, prior to construction of the pavement build-up.

Within the sports pitch engineered fill, the twenty tests recorded dynamic modulus values generally in the range of 21MPa to 26MPa, with equivalent CBR values generally between 5.3% and 7.5%; one test (LWD25) recorded a locally higher value of 15.0%. Given the shallow depth of influence of the LWD test (approximately 1.5 times the plate diameter), these results are considered representative of the immediate near-surface condition of the fill rather than a bulk measurement through its full depth and are consistent with the strength range recorded by the Continuous SPT Probing and DCP testing described in Sections 5.3.2 and 5.3.3.

LWD2, located in proximity to DCP tests TRL26 and TRL31 (Section 5.3.3), recorded a dynamic modulus of 22MPa and equivalent CBR of 5.7%, within the general range recorded across the sports pitch fill surface and with no indication of a wider zone of weakness. This corroborates the assessment in Section 5.3.3 that the locally low CBR values at TRL26 and TRL31 are isolated rather than systemic.

Within the access track, the five formation-level tests recorded substantially higher stiffness, with dynamic modulus values of 49MPa to 141MPa and equivalent CBR values of 20.8% to 114.1%. These results demonstrate that the engineered fill forming the access track formation has achieved a materially higher standard of near-surface stiffness than the sports pitch fill, consistent with the greater degree of compaction required to support trafficked construction.

Overall, the LWD results confirm that the engineered fill exhibits satisfactory near-surface stiffness across the validated sports pitch area, consistent with the strength profile demonstrated at depth by the SPT and DCP data, and that the access track formation has achieved a stiffer near-surface condition appropriate to the demands of trafficked pavement construction.

## 5.4 CHEMICAL VALIDATION TESTING

Representative soil samples were recovered from both the completed engineered fill and the overlying pitch make-up soils during the windowless sampling investigation and submitted to the UKAS accredited laboratories of i2 Analytical for laboratory chemical testing.

Testing comprised metals and semi-metals, inorganic chemicals, polyaromatic hydrocarbons (PAHs), petroleum hydrocarbons and asbestos.

The laboratory test certificates are presented in Appendix J, with summary tables and screening assessments presented in Appendices L and M.

The Suitable 4 Use Levels (S4ULs) published by LQM have been adopted as the principal assessment criteria against which soil contaminant concentrations have been compared. In the absence of published S4ULs for individual contaminants, the Category 4 Screening Levels (C4SLs) published by DEFRA and Soil Screening Values (SSVs) derived by Atkins ATRISKsoil have been adopted where considered appropriate.

Chemical testing undertaken on representative samples recovered from the completed engineered fill demonstrated that concentrations of metals, semi-metals, inorganic chemicals, PAHs and petroleum hydrocarbons were below the adopted assessment criteria. Three samples (WS01, WS08 and WS15) contained isolated asbestos-containing materials comprising loose amosite fibres, a chrysotile-containing bitumen fragment and loose chrysotile fibres respectively. Quantitative asbestos analysis confirmed asbestos concentrations of less than 0.001% by weight within each of these samples.

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#### **5.4 CHEMICAL VALIDATION TESTING (CONTINUED)**

Seven representative samples recovered from the completed pitch make-up soils were also submitted for laboratory chemical testing. All analytical results were below the adopted assessment criteria and asbestos was not detected in any of the pitch make-up soil samples.

Windowless sample boreholes confirmed that the completed sports pitch construction generally comprises approximately 300mm of pitch make-up soils overlying a geotextile separation membrane and the underlying engineered fill. The laboratory testing demonstrates that the pitch make-up soils are chemically suitable for the proposed end use. The trace asbestos-containing materials identified within three engineered fill samples are located beneath the completed pitch make-up and geotextile separation membrane.

#### **5.5 VALIDATION SUMMARY**

Laboratory geotechnical testing confirmed that the processed site-won materials placed beneath the sports pitch and access track comprise SHW Class 2C and Class 2A/2B engineered fill in accordance with Series 600 of the Specification for Highway Works. Both material classifications are suitable for use as engineered fill under the project Earthworks Specification.

Chemical validation testing undertaken on representative samples recovered from the completed sports pitch construction demonstrated that the pitch make-up soils comply with the adopted assessment criteria for the proposed end use. Trace asbestos-containing materials were identified within three samples recovered from the underlying engineered fill; however, quantitative analysis confirmed asbestos concentrations of less than 0.001% by weight in each case. Windowless sample boreholes confirmed these materials are located beneath the completed pitch make-up and geotextile separation membrane.

Windowless sample boreholes confirmed the general construction profile of the completed sports pitch, comprising approximately 300mm of pitch make-up soils overlying a geotextile separation membrane and engineered fill. The boreholes also confirmed the engineered fill to comprise firm to stiff sandy gravelly clay consistent with the processed site-won materials used during the earthworks.

## 5.5 VALIDATION SUMMARY (CONTINUED)

Continuous SPT Probing demonstrated generally consistent penetration resistance throughout the engineered fill profile across both the sports pitch and access track. Dynamic Cone Penetrometer testing demonstrated the anticipated increase in strength beneath the pitch make-up layer, whilst Light Weight Deflectometer testing confirmed a generally consistent stiffness response across the completed platform. Higher penetration resistance, CBR values and stiffness were generally recorded within the access track, reflecting the differing engineering requirements of the access track and sports pitch construction.

Taken together, the laboratory geotechnical testing, chemical validation testing and in-situ verification testing provide a consistent body of evidence demonstrating that the engineered fill beneath the sports pitch and access track has been placed and compacted in general accordance with the requirements of the Earthworks Specification (Reference BCA-IGW-XX-XX-RP-G-0007-S2-P01). The validation testing also confirms the general composition of the completed sports pitch construction and the chemical suitability of the pitch make-up soils for the proposed end use.