

Bexley TLC

Galliford Try

STAGE 3 REPORT

STRUCTURAL / CIVIL ENGINEERING

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1.0 DESCRIPTION OF THE PROJECT

- 1.1 AKSWard have been appointed by Galliford Try to provide Civil and Structural Engineering Design in relation to a proposed new educational facility in Eltham in London.
- 1.2 Works involve the construction of a new single storey school building along with associated external landscaping, including a bin store and a cycle store.
- 1.3 This report summarises the site conditions, design parameters and design philosophy which will be adopted for the project during the next phase of works.

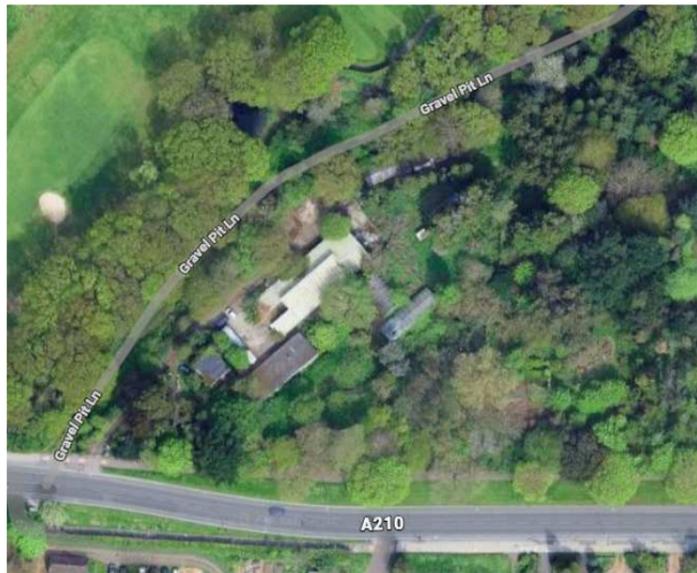


Figure 1 – Aerial Photograph of Site

2.0 EXECUTIVE SUMMARY

- 2.1 AKSWard have been appointed to provide Civil and Structural Engineering Design. This report summarises the site conditions, design parameters and design philosophy which will be adopted for the project.
- 2.2 The site investigation shows significant depths of made ground, overlaying Harwich Formation, overlaying Lambeth Group clays at depth.
- 2.3 As a result of the site investigation results, a piled slab will be adopted for the ground floor and foundation solution.
- 2.4 The site investigations states that the made ground should be consider as contaminated, with a remediation strategy provided which offers guidance on cover depths required.
- 2.5 A steel frame solution for the super structure appears appropriate, with an SFS inner leaf and metal stud internal partitions.
- 2.6 The surface water will be attenuated on site before being discharged into the Thames Water network to the south of the site.

2.7 The foul water will be discharged into a private network to the south of the site.

3.0 SITE CONDITIONS

3.1 The Site

- 3.1.1 The site is currently unoccupied and comprises primarily of woodland with a number of disused structures on the western side of the site.
- 3.1.2 The site is bounded to the south by the A210, Bexley Road, to the north and west by Gravel Pit Lane, and to the east by Stationer’s Crown Woods Academy.

3.2 Ground Conditions

3.2.1 An initial site investigation was carried out in March 2023 by Ridge and Partners (5019466-RDG-XX-ST-DOC-C-00GIR01). This was then followed up with a further site investigation in July 2023 (5019466-RDG-XX-ST-DOC-C-00FGIR01) to carry out ground gas monitoring as well as to provide more information of the deeper soils. In addition to this due to the contamination found during the site investigation, a remediation strategy has also been prepared (5019466-RDG-XX-ST-DOC-C-00RMS01).

Table 1 below indicates a summary of the ground conditions found in the site investigation.

Stratum	Composition	Depth to top	Depth to base
Made Ground	Dark brown clayey gravelly sand	Ground level	1.2m-2.7m
Harwich Formation	Light brown to brown gravelly sand	1.2m-2.7m	4.0m-6.0m
Lambeth Group	Grey sandy clay and light grey to grey sand	4.0m-6.0m	9.5m (maximum depth of SI)

Table 1: Summary of Ground Conditions

Source: Ridge Site Investigation Report

- 3.2.2 The clays have been found to be of medium and high shrinkage potential. As a result heave protection will be required to the underside of the new building.
- 3.2.3 The natural soils from 3.0m bgl are considered suitable for traditional foundations, however due to the depth this is considered unlikely to be economical.
- 3.2.4 Groundwater was encountered between 2.9m and 3.5m bgl during the site investigation and between 2.61m and 3.66m bgl during monitoring visits.

4.0 STRUCTURAL DESIGN STANDARDS

4.1 The design and construction of the structure shall conform to relevant British Standards, Eurocodes and other Technical Publications, (latest editions as amended) and in particular:

Building Regulations 2000 Edition

BS EN 1990	Eurocode 0: Basis of Structural Design
BS EN 1991	Eurocode 1: Actions on Structures
BS EN 1992	Eurocode 2: Design of Concrete Structures
BS EN 1993	Eurocode 3: Design of Steel Structures
BS EN 1994	Eurocode 4: Design of Composite Structures
BS EN 1995	Eurocode 5: Design of Timber Structures
BS EN 1996	Eurocode 6: Design of Masonry Structures
BS EN 1997	Eurocode 7: Geotechnical Design
BS EN ISO 12944	Paints & Varnishes. Corrosion Protection of Steel Structures by Protective Paint Systems
BS EN ISO 14713	Zinc Coatings. Guidelines and Recommendations for the Protection Against Corrosion of Iron and Steel in Structures.
BCSA	National Structural Steelwork Specification for Building Construction (4 th Edition)
BCSA	Structural Steelwork Fabrication
BS 8500-1:2006 + A1 2012	Concrete
BS 8102: 2009	Code of Practice for Protection of Structures Against Water Ingress From The Ground
BS 5606	Accuracy in Building

4.2 All materials to be incorporated into the works shall be manufactured to the relevant British or European Standard and obtained from a recognised source, carrying the relevant certification of quality control. Suitable records of material quality shall be kept by the contractor and issued to the Employer's Agent as agreed during the construction period.

5.0 LOADING DATA

5.1 The roof and floor slabs are to be designed for the following imposed loads in addition to the self-weight of the structure and all applied finishes.

Roof

General Areas	-	0.75 kN/m ²
Plant	-	5.00kN/m ²

Floors

Classrooms and Corridors	-	4.00 kN/m ²
Plant	-	7.50 kN/m ²
Water Tank Room	-	10.00kN/m ²

5.2 A dead load allowance of 0.4 kN/m² for ceiling and services will be provided throughout. Where specific large items of plant are to be suspended from the ceiling, the loading from these items will be considered in addition to this allowance.

5.3 3No. of the classrooms will have a hoist in them. For each of these an allowance will be made of 1.5 times the S.W.L. at any point along the track in accordance with the manufacturer's guidance.

5.4 The current design has an area of PVs on the roof. An allowance of 0.4kN/m² has been made for these. This allowance has been allowed for across the entirety of the roof to allow for future additional PV installation.

5.5 The main structure, the roof and the external walls are to be designed to resist wind loads calculated in accordance with BS EN 1994-1-4.

6.0 DURABILITY & DESIGN LIFE

6.1 Building is to be designed for a 60-year design life.

7.0 LATERAL STABILITY & ROBUSTNESS

7.1 The structure is to be designed to have adequate resistance against sway.

7.2 Stability of the structure against horizontal forces is to be provided by a series of braced bays. These will be located in solid panels so that they do not foul windows or openings. Lateral loads arising from wind forces will be transmitted into the roof structure via the cladding elements. These will then be transferred to the braced bays via diaphragm action of the composite roof deck and down into the foundations.

Consequence class	Example of categorisation of building type and occupancy
1	Single occupancy houses not exceeding 4 storeys. Agricultural buildings. Buildings into which people rarely go, provided no part of the building is closer to another building, or area where people do go, than a distance of 1 1/2 times the building height.
2a Lower Risk Group	5 storey single occupancy houses. Hotels not exceeding 4 storeys. Flats, apartments and other residential buildings not exceeding 4 storeys. Offices not exceeding 4 storeys. Industrial buildings not exceeding 3 storeys. Retailing premises not exceeding 3 storeys of less than 1 000 m ² floor area in each storey. Single storey educational buildings All buildings not exceeding two storeys to which the public are admitted and which contain floor areas not exceeding 2000 m ² at each storey.
2b Upper Risk Group	Hotels, flats, apartments and other residential buildings greater than 4 storeys but not exceeding 15 storeys. Educational buildings greater than single storey but not exceeding 15 storeys. Retailing premises greater than 3 storeys but not exceeding 15 storeys. Hospitals not exceeding 3 storeys. Offices greater than 4 storeys but not exceeding 15 storeys. All buildings to which the public are admitted and which contain floor areas exceeding 2000 m ² but not exceeding 5000 m ² at each storey. Car parking not exceeding 6 storeys.
3	All buildings defined above as Class 2 Lower and Upper Consequences Class that exceed the limits on area and number of storeys. All buildings to which members of the public are admitted in significant numbers. Stadia accommodating more than 5 000 spectators Buildings containing hazardous substances and/or processes

Figure 3: Categorisation of Consequence Classes

Source: Building Regulations - Approved Document A

- 7.3 In accordance with BS EN 1991-7 the building shall be designed as a Class 2A building. As such the structure will be designed with effective horizontal and vertical ties together with confirmation checks of the integrity of the building following notional removal of vertical members and the design of key elements in accordance with recommendations in relevant codes and standards.
- 7.4 Temporary stability of the building during construction will be considered during design development. Any requirements for temporary stability systems during construction will be agreed and coordinated with the contractor to suit their methods and sequence of construction and designed by their temporary works engineer.

8.0 SERVICEABILITY CRITERIA

8.1 Deflection

- 8.1.1 The structure is to be designed so that the deflections under serviceability loads do not impair the strength or efficiency of the structure or cause damage to the finishes. Deflection limits to be generally as follows:

Steel Beams

TOTAL DEFLECTION (DEAD + LIVE)	LIVE LOAD DEFLECTION
SPAN / 250	SPAN / 360

Steel Cantilevers

TOTAL DEFLECTION (DEAD + LIVE)	LIVE LOAD DEFLECTION
SPAN / 125	SPAN / 180

Overall Horizontal Deflections Due to Wind and Equivalent Horizontal Forces

TOTAL DEFLECTION (WIND + NOTIONAL HORIZONTAL LOADS)
HEIGHT OF STOREY / 300

Beam Supporting Exterior Facade

DEFLECTION DUE TO IMPOSED LOADS
LIMITED TO 10mm

9.0 MOVEMENTS

- 9.1 It is important to recognise that it is difficult to rigorously ascertain the design parameters upon which deflection and movement calculations are based. There are many factors which influence these parameters, including temperature, humidity, sequence of works, accuracy of workmanship, variation in

material properties, curing periods, temporary works, time of loading, along with many more such factors.

- 9.2 Accordingly, for steel and concrete structural elements of the building, the deflections and movements quoted shall be regarded as mean estimates only. Movement of foundations are even more difficult to predict given the variability of the ground conditions. Consequently, there is a far greater uncertainty in the soil properties and design parameters, upon which settlement calculations are based, and therefore predicted movements should be considered approximate.

9.3 Horizontal Movements

- 9.3.1 Horizontal movements of the building will be caused by both static and dynamic loads as a consequence of the following factors:

- Wind forces
- Notional affects (due to building imperfections)
- Shrinkage of concrete as it cures.
- Creep
- Soil-structure interaction
- Expansion and contraction caused by temperature changes in the structure.
- Temporary works

9.4 Vertical Movements

- 9.4.1 Vertical movements of the building will be caused by both static and dynamic loads as a consequence of the following factors:

- Settlement of foundations
- Wind forces
- Snow loads
- Floor deflections
- Elastic axial shortening of steel frame columns from vertical loads.
- Notional affects (due to building imperfections)
- Temporary works

9.5 Thermal Movements

- 9.5.1 Movements arising from thermal effects will be at their greatest during the construction period, when the structure will be exposed to greater variations in the ambient temperature. The amount of movement the building will experience will reduce once the building is complete and has climate control.

- 9.5.2 As part of detailed design thermal movements will be estimated for each area based upon a temperature variation of 30°C (-5°C to +25°C).

- 9.6 Movements will be considered in detail as part of the next phase of design.

10.0 BUILDING TOLERANCES

- 10.1 The tolerances given in BS5606 – Accuracy in Building, the National Structural Steelwork Specification (NSSS) and the National Structural Concrete Specification (NSCS) shall be strictly adhered to. This is to avoid interface problems with following trades.
- 10.2 As described in BS5606 tolerances are assumed to be combined and that inherent deflections are to be added arithmetically.

11.0 FIRE RESISTANCE

- 11.1 For fire protection requirements refer to the Architect’s specification.
- 11.2 As the building is single storey there is no requirement to consider fire protection of the steel frame with regards to the stability of the building.

12.0 STRUCTURAL STRATEGY

12.1 Sub-structure & Ground Floor Slab

- 12.1.1 The initial SI found that the made ground was not suitable for ground bearing foundations. Due to the depth of the made ground across the site the minimum depth for ground bearing foundations was recommended as 3.0m and, as such, ground bearing foundations are not considered suitable for the new building.
- 12.1.2 The further SI report advised on preliminary pile capacities.
- 12.1.3 The SI recommends the use of a suspended floor slab due to the depth of made ground and the high volume change potential soils.
- 12.1.4 As a result of the ground conditions, a piled slab will be used for the foundations and ground floor. Heave protection will be required to the underside of the slab.

12.2 Superstructure

- 12.2.1 A hot rolled steel frame is proposed for the primary superstructure. This will utilise 140x140 square hollow sections (SHS) for the column members so that they can be hidden within the internal walls with no projections in to useable spaces.
- 12.2.2 Traditional universal beam (UB) sections will form the structure at roof level, with a PFC rail spanning between the columns to form the parapet. The cantilever canopy will be formed from steel hollow sections with timber joists for infill.
- 12.2.3 Stability is provided by a series of braced bays located around the building. These braced bays will be diagonal 140x140 SHS members and will align with the columns.
- 12.2.4 A composite deck is envisaged for the roof structure. The deck will be designed to not require any propping in the temporary condition, and when fully fixed to the primary roof steels will act as a diaphragm to transfer horizontal loads to the braced bays and remove the need for roof bracing.

- 12.2.5 Whilst many materials can be used to construct the inner leaf and the internal walls, including load bearing masonry, timber stud and SFS, at this stage it is envisaged that SFS will be used for the inner leaf of the external walls, with metal stud walls for the internal partitions.

13.0 BUILDING MATERIALS

13.1 Steelwork

- 13.1.1 Generally, all structural steelwork will be in accordance with the following recommendations:
- Steelwork fabrication to be in accordance with BS EN 1993 and the NSSS.
 - Steelwork contractor will provide temporary erection bracing to ensure a stable structure at all times during erection.
- 13.1.2 All steelwork to be grade S355JR to BS EN 10025 and S355JON to BS EN 10210 and in accordance with the AKSWard specification.
- 13.1.3 The Main Contractor is to apply the final coat of paint to all exposed structural steelwork to the Architect’s specification.

13.2 Internal Steelwork

Steelwork to be blast cleaned to BS EN ISO 851-1, preparation grade SA2½ followed by chemical cleaning and primed with zinc phosphate epoxy primer, dry film thickness 80 microns (nominal) and compatible with the any fire protection.

13.3 External Steelwork

Steelwork to be galvanised to BS EN ISO 1461, blast cleaned to BS EN ISO 851-1, preparation grade SA2½ followed by chemical cleaning and to receive minimum mean coating thickness 140 microns and compatible (where required) with the any fire protection or external paint finish.

13.4 Concrete

- 13.4.1 All concrete to be designed reinforced concrete mix, to BS EN 1992 & BS EN 206.

14.0 CIVILS STRATEGY

14.1 Below Ground Drainage

- 14.1.1 The design of this element of works shall conform to the relevant requirements as set out in the following policies and guidance documents
- Sewers for Adoption 7th Edition
 - Part H Approved Building Regulation Document
 - Royal Borough of Greenwich SFRA (level 1 – 2017, Level 2 – 2018)
 - Planning and Policy Statement 25 Development and Flood Risk
 - Design and Analysis of Urban Drainage The Wallingford Procedure
 - Ciria Document C697 The SuDS Manual
- 14.1.2 AKSWard are responsible for the design of the external below ground drainage associated with the building and external hardstanding areas.

14.1.3 Once installed all new drainage shall be tested in accordance with the relevant British Standards.

14.1.4 All new works to be flushed / jetted clean and CCTV surveyed prior to handover. Report and DVD to be supplied to the engineer for review.

14.2 Foul Water Drainage

14.2.1 All new foul drainage serving the building will be collected and discharged via gravity to the existing foul water sewer to the south of the building.

14.2.2 A capacity check has been made showing the foul drainage will discharge into a private sewer. Permission to discharge the drainage into the private network will be obtained once the ownership of the network is made clear.

14.2.3 The design of the system will be based on BS EN 12056-2, BS EN 12056-4 and Building Regulations Part H.

14.3 Surface Water Drainage

14.3.1 The site will discharge into an existing Thames Water public manhole (ref: 0601 & 9601) located on Bexley Road to the south of the site.

14.3.2 The surface water for the new building will be collected via the above ground rainwater pipes. The surface water for the roads shall be collected via a permeable paving and overflow gully system. The impermeable footpaths shall have its surface water run-off collected via linear drainage channels.

14.3.3 The surface water will flow through an online crate attenuation tank before it reaches the outfall. This crate system will be non-infiltrating to the ground as the soil condition has been categorised as contaminated.

14.3.4 To reduce the magnitude of the crate attenuation, flow controls will be placed downstream of the permeable paving connections to reduce discharge rates and utilises the storage capacity of the permeable sub-base of the road.

14.3.5 The surface water shall be routed through a piped network and crate storage system, discharging at a rate of 2.5l/s into TWMH 0601 and 1.0l/s into TWMH 9601 as confirmed by the capacity check made with Thames Water.

14.4 Statutory Agreements

14.4.1 All statutory agreements required for the discharge of both foul and surface water will be made by AKSWard at the appropriate stage of design.

14.5 External Works

14.5.1 All external works are specified by the landscape architects. Our build ups, layouts and levels are based on CBR data provided and material types from the landscape architects.

14.6 Cut & Fill

14.6.1 As part of the civils scope of works, a cut and fill analysis of the site was undertaken. The cut and fill are based on the following documents for the existing and proposed levels:

- LT/222/0011/P/0001-0004 _ P01 Topographical Survey
- BTLC-UBU-XX-DR-L-1000_P02 Preliminary Landscape Masterplan

14.6.2 The Soil Investigation report identified that the site is set on contaminated ground meaning that in an areas of soft landscaping a site strip of 600mm is required as confirmed in the soil investigation report. The construction depths that have been used as to create the formation layer of the site is as follows:

- Road Build up: 495mm
- Road Build up (TRPZ): 245mm
- Footpath Build up: 200mm
- Footpath Build up (TRPZ): 185mm
- Soft Landscaping: 150mm (600mm site strip for contaminated ground)
- Soft Landscaping (TRPZ): 150mm
- Building Pad: 1340mm
- Utility pads: 450mm

15.0 SUSTAINABILITY

15.1 The following will be considered at later design stages to reduce the embodied carbon of the structure

- Reduction in weight of the steel frame – once more exact loading information is available the steel sizes will be reassessed to reduce tonnage
- Utilisation of additives in the concrete mix to reduce the cement content

15.2 Due to the contamination present in the ground it will not be possible to reuse any cut material as fill elsewhere on site.

16.0 UNRESOLVED STAGE 3 DESIGN ISSUES

16.1 Detailed design has yet to commence so the majority of items are technically unresolved, however the list below highlights critical elements which require further work:

- Secondary steelwork for the support of the hoists.
- Secondary steelwork for the support of roof mounted plant and plant enclosure.
- External slabs for bin store, cycle store and others.
- External retaining walls.

17.0 SUB-CONTRACTORS WITH CIVIL OR STRUCTURAL DESIGN RESPONSIBILITY

17.1 The following is a list of elements that are not included within the design duties of the civil and structural engineer. These items would form part of a sub-contractor design package following appointment of the main contractor. The main contractor will need to allow sufficient time within their programme for all of the coordination of a detailed design. The performance criteria for these elements would be provided by the Design Team.

17.2 List of design packages that will form part of the Contractor’s Design Portions (CDP):

- Design, detailing and coordination of all temporary works.
- Design of piles and piling mat.
- Design, detailing and coordination of all precast elements.
- Cladding and any associated secondary support structure, restraints and fixings required to take support from the primary structure. Includes masonry support systems, stone cladding, rain screens, curtain walling, glazing and brise soleil.
- Internal glazed partitions / stud partitions / doors / moveable walls / hanging walls, their support and fixing back to the primary structure.
- Architectural metal works and fixings back to the primary structure.
- Handrails / balustrades and fixings back to the primary structure.
- Man-safe and window cleaning systems and fixings back to the primary structure.
- Steel access stairs (to external roof areas and plant rooms) / cat ladders and fixings back to the primary structure.
- Secondary support and additional builder’s work items and fixings back to the primary structure. Includes secondary plant support frames, plant support bases, suspended ceilings.
- Steel to steel connection design, which would be provided by the fabricator.
- All secondary cold-formed steelwork, including SFS and their fixings back to the primary structure.
- Ground floor waterproofing.

18.0 CIVIL & STRUCTURAL DESIGN RISKS

18.1 The primary risks to be identified to date are tabulated below, together with any mitigation measures:

Risk	Mitigation
Underground live utilities onsite	Survey and identify any existing utilities on site.
Outfall manholes levels differ to asset map values	Survey of manholes and conditions to confirm levels and suitability to connect to.

19.0 ADDITIONAL SURVEYS / INVESTIGATIONS

19.1 The following is a list of additional surveys and investigations which need to be undertaken:

- Existing Foul Drainage Network on the site.
- Surface Water Outfall Manholes
- Below ground utilities of existing utilities