



ENGINEERING & ENVIRONMENTAL CONSULTANTS

**Ground Movement Assessment
in relation to
Thames Water Assets
At
Cranwood House
Woodside Avenue
Muswell Hill
London
N10 3JA**

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1.0 INTRODUCTION

Cranwood House currently occupies a corner site bounded by Muswell Hill on the east, Woodside Avenue to the north and west and residential properties to the south as indicated in Figure 1 below. It is proposed to demolish the existing Cranwood House and construct a new development of residential properties on the site in accordance with the planning granted by Haringey Planning Department on the 10th October 2022 under planning reference HGY/2021/2727.

There are currently two Thames Water Assets which traverse the site, Asset 1 is a 300mm diameter Foul Water Sewer which enters the property at the northwest corner of the site and exits approximately mid-way down the east side of the site onto Muswell Hill Road, this asset is at an approximate depth of 5.0m to the crown of the pipe. Asset 2 is a brick services tunnel which carries a number of water pipes presumably to the Thames Water facilities and underground reservoir located some distance to the west of the site along Woodside Avenue. This tunnel is an oval shaped brick structure the crown of which is approximately 3.90m below ground level.



Figure 1 Aerial View of Site indicating TW Assets. Cranwood House (yet to be demolished) can be seen to have been built over the 300mm diameter Foul water sewer.

2.0 SITE DEVELOPMENT AND CONTEXT.

The Developments in and around the site are predominantly residential type properties, however the site immediately to the west is occupied by St. James's Primary School. Cranwood House is a brick clad structure of two/three stories in height built in the 1970's and has been used as a Care Home in the past.

Prior to the development of the site for Cranwood House the site was occupied by a Train station and sidings which appear to have ceased operations in the 1960's. The 1962/1968 maps for the area

indicate a shaft on the site which did not appear in the earlier maps. This shaft is located approximately over the Thames Water tunnel and on the eastern boundary adjacent to Muswell Hill Road. This shaft coincides with the appearance of another shaft further to the west located on the grounds of the Thames Water facilities on Woodside Avenue and also with the appearance of the Thames Water facilities themselves at this time. – see Figure 2.

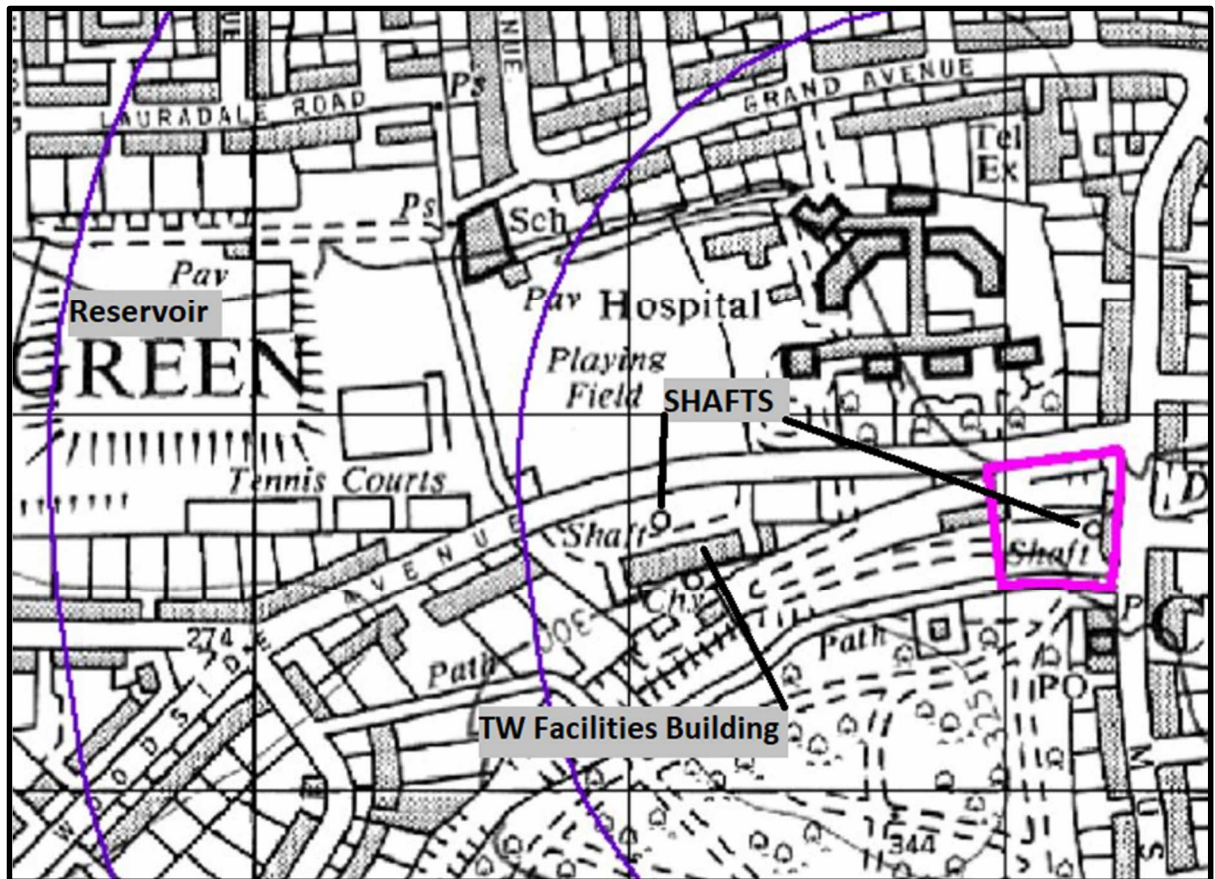


Figure 2 Extract from 1922/1968 Map indicating shafts.

The shaft on the site also appears on the topographical survey an extract of which is provided in Figure 3 below. A point cloud survey was carried out from within the tunnel during the condition survey of the tunnel from which a 3 D rendering of the access manholes on Muswell Hill Road and the shaft has been produced, this is provided in Figure 4 below. It can be seen from the survey that the shaft extends to the top of the tunnel and is most likely an air vent. We assume that this shaft is there to provide ventilation to the tunnel and release any pressure build up within the tunnel.

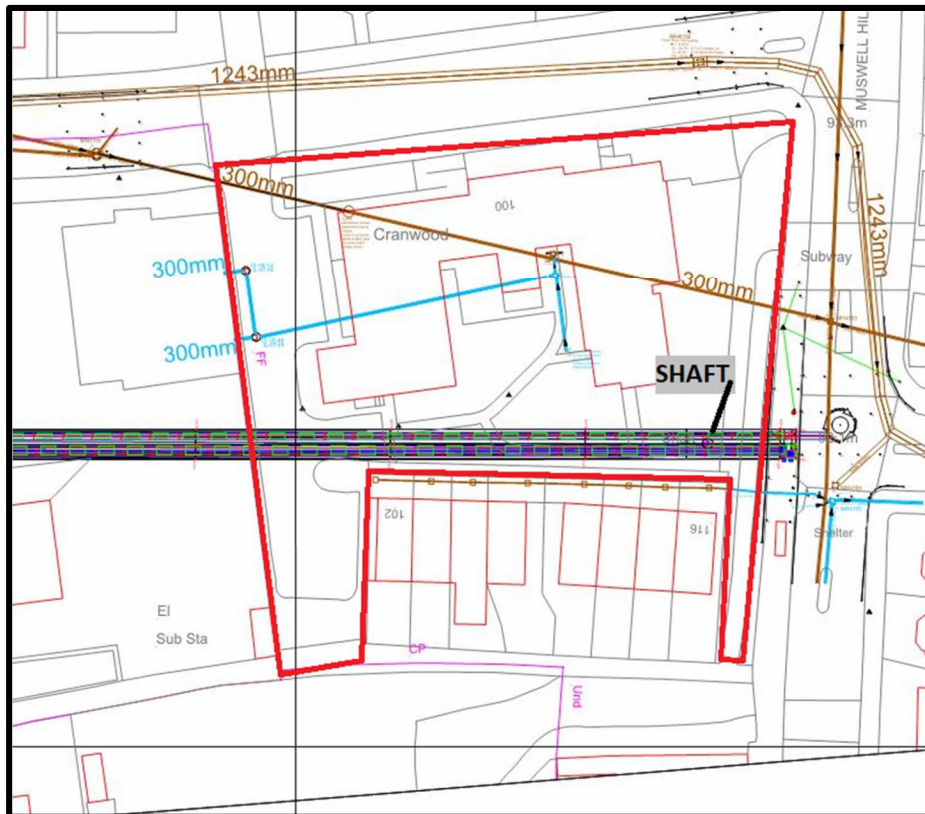


Figure 3 Extract from Topographical map indicating Shaft.

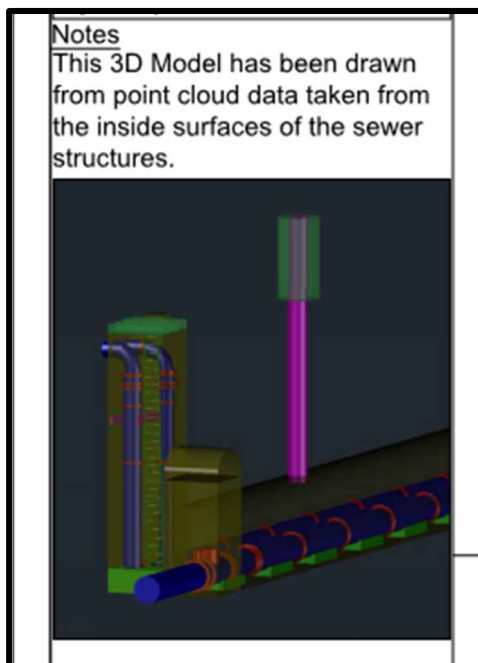


Figure 4 Point Cloud Survey of Tunnel indicating shaft, also access manholes located in Muswell Hill Road.

It is not intended to construct a basement to any of the proposed buildings, however the levels on site are lower around the existing and proposed buildings than around the perimeter of the site however in general the site levels are to be retained close to the existing levels.

The cover to the 300mm diameter Foul Sewer varies from approximately 7.10m to approximately 4.90m. For the tunnel the cover to the top of the structure varies from 4.80m to 4.20m.

The relationship between the 300mm diameter Foul Sewer and the Tunnel to the proposed new structures are indicated in the cross sections produced by MWP Consulting Engineers and outlined in their drawings CRA-MWP-ZZ-00-DR-S-0101, CRA-MWP-ZZ-00-DR-S-0201 and CRA-MWP-ZZ-00-DR-S-0202 copies of which are appended to this report with extracts included in Figures 5, 6 and 7 below as a visual guide.

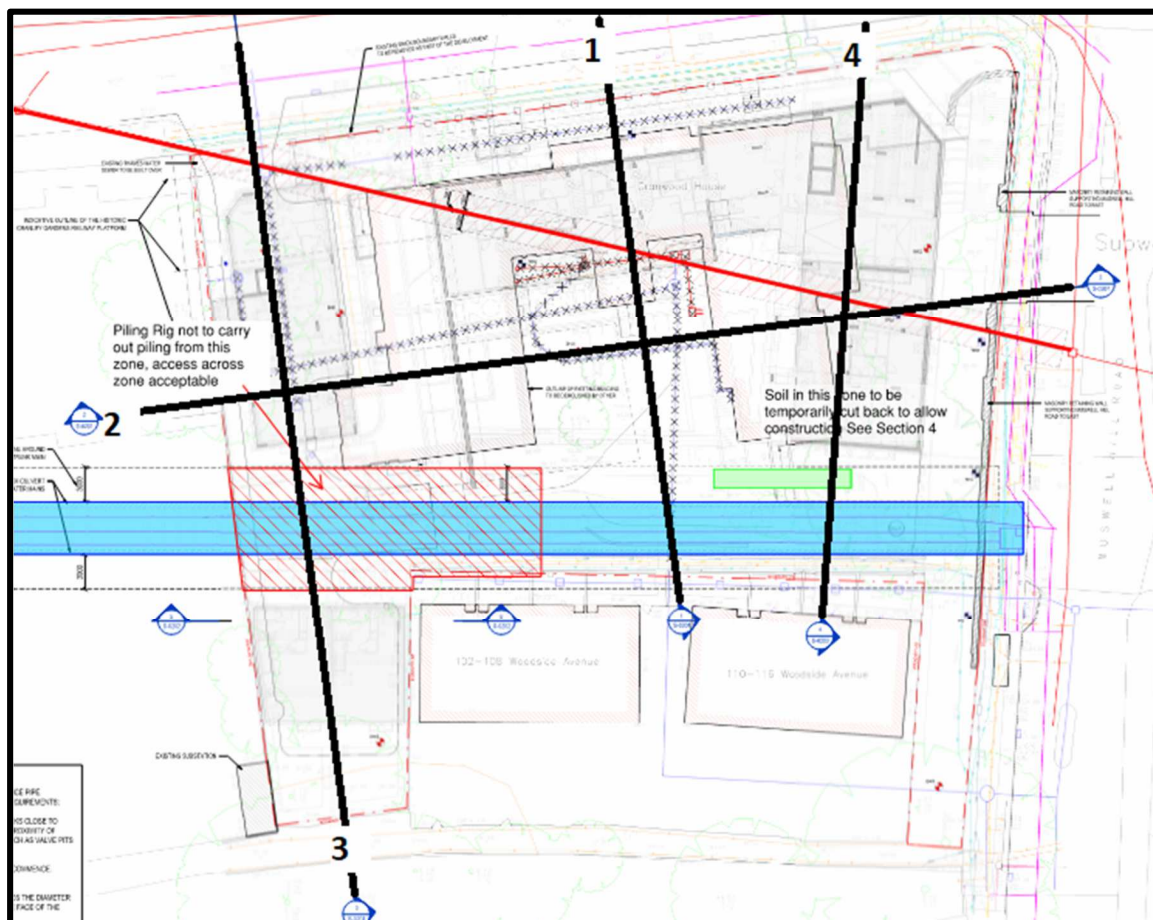


Figure 5 Site Layout indicating site constraints and Section Locations - Extract from MWP Drawing CRA-MWP-ZZ-00-DR-S-0101

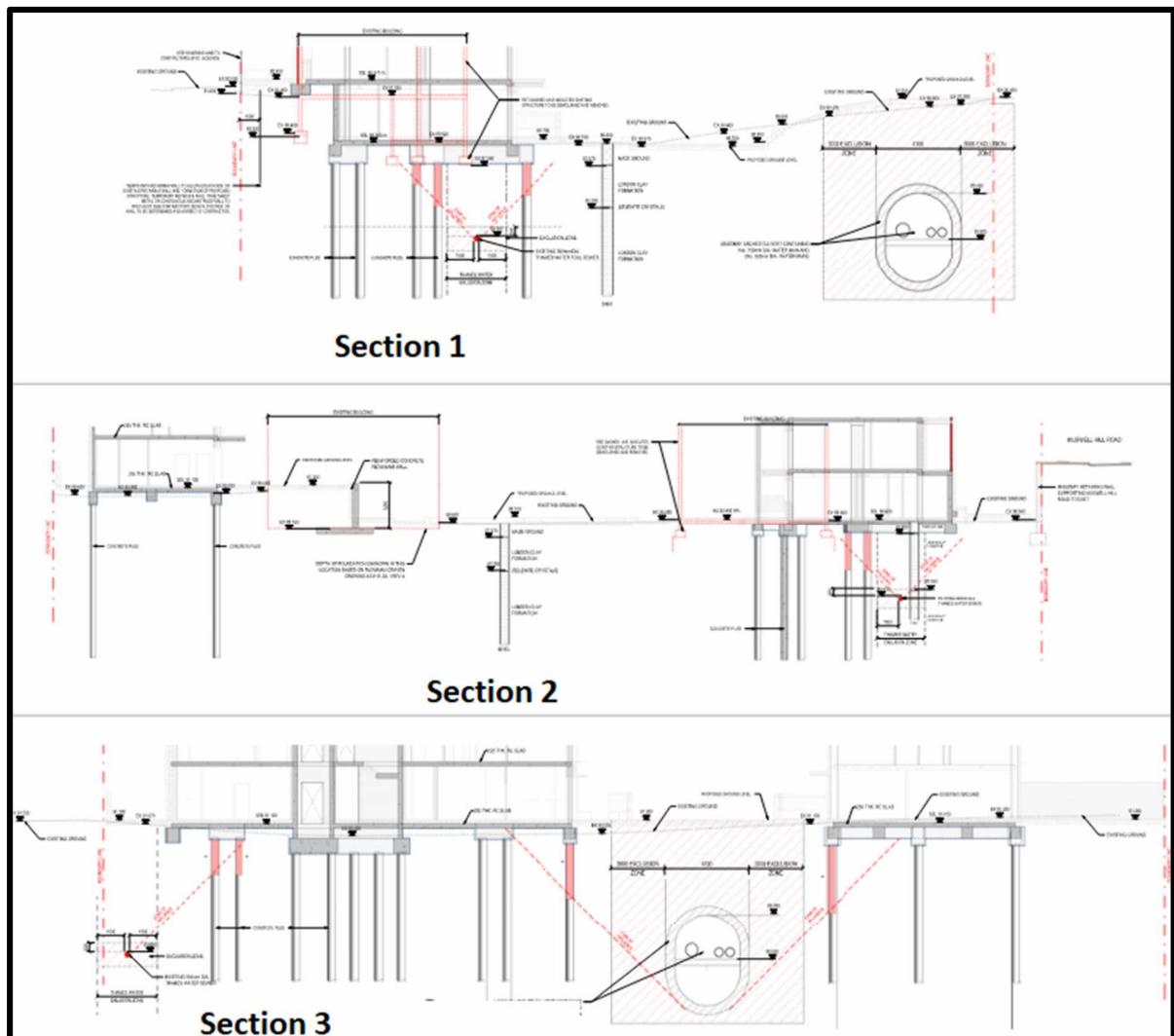


Figure 6 Extract from MWP Drawing CRA-MWP-ZZ-00-DR-S-0201 Sections 1, 2 and 3.

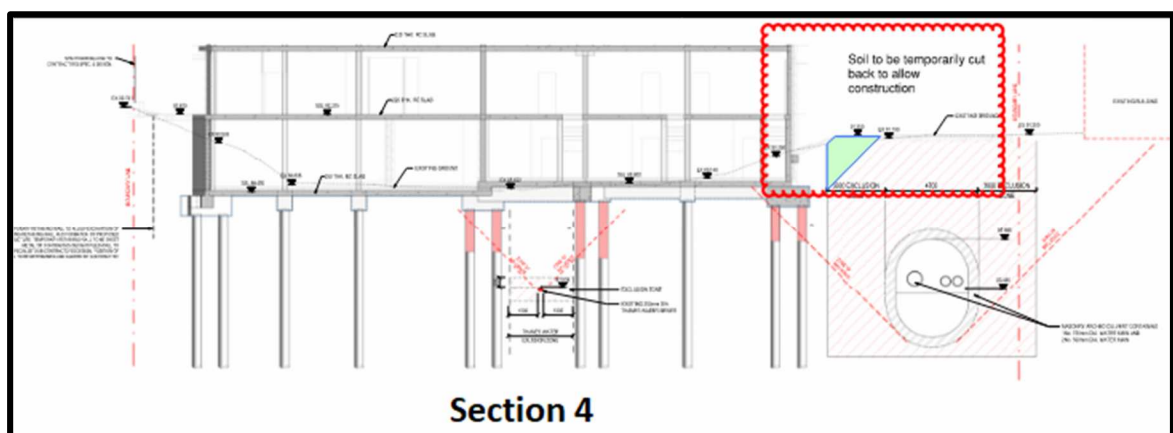


Figure 7 Extract from MWP Drawing CRA-MWP-ZZ-00-DR-S-0202 Section 4.

3.0 GROUND INVESTIGATION WORKS, GEOLOGY AND SURVEYS.

A Ground Investigation report on the site has been produced by Soiltechnics Limited and dated May 2021. This report was based on intrusive ground investigation works carried out between December 2020 and January 2021.

The ground investigation recorded depths of Made Ground varying from 0.5 to 1.0m deep overlying London Clay which was proven to a minimum depth of 25m below ground level. A review of the Borehole records held by the British Geological Survey by MWP revealed a borehole located adjacent to the Thames Water Facilities on Woodside Avenue which extended to a depth of 178m below ground level recording 100m of London Clay overlying 19m of Woolwich and Reading Beds (Lambeth Group) over the Upper and Lower Chalk.

An extract from the British Geological Survey Sheet 256 London North is produced below, this indicates possible head deposits above the London Clay, it is possible that the Made ground recorded during the Ground Investigation may have been Head Deposits.

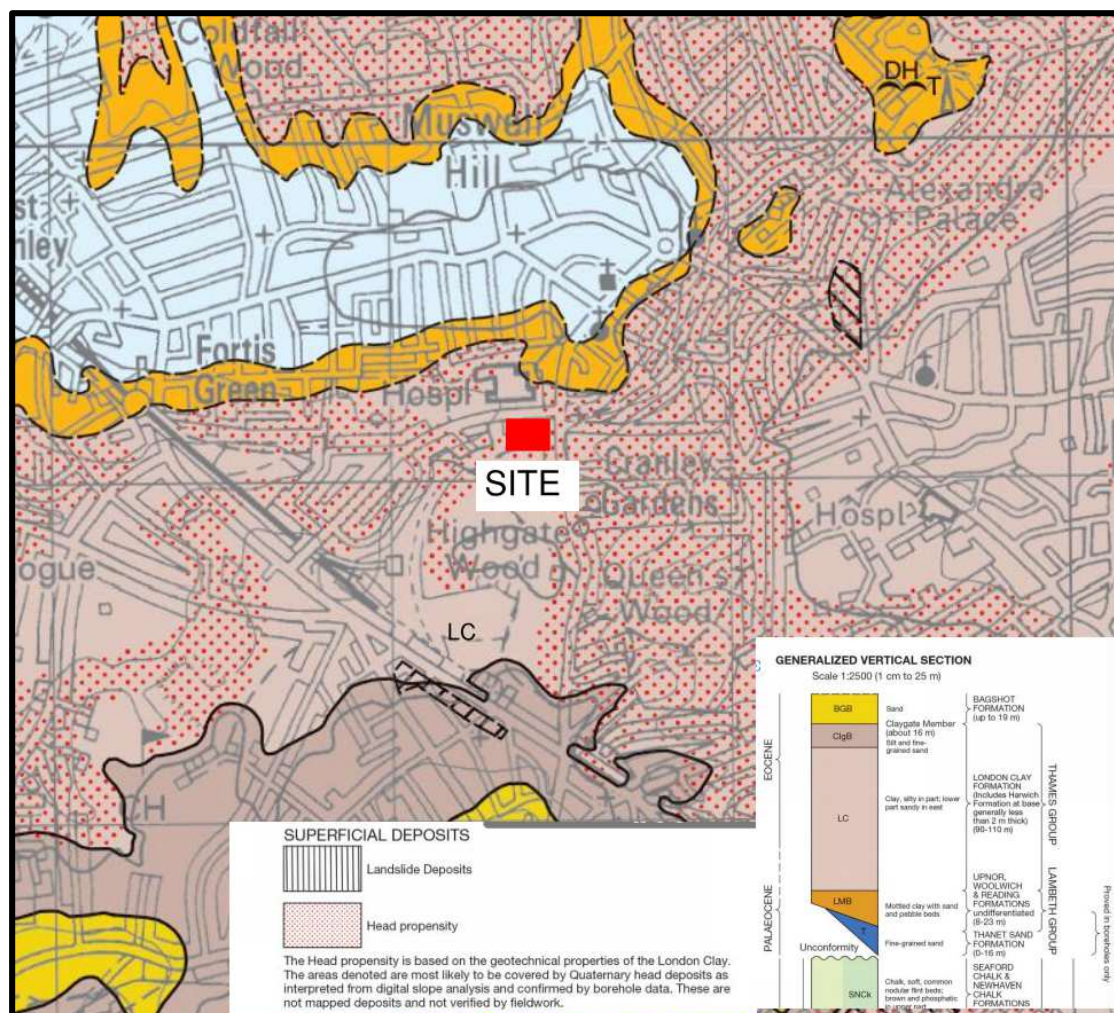
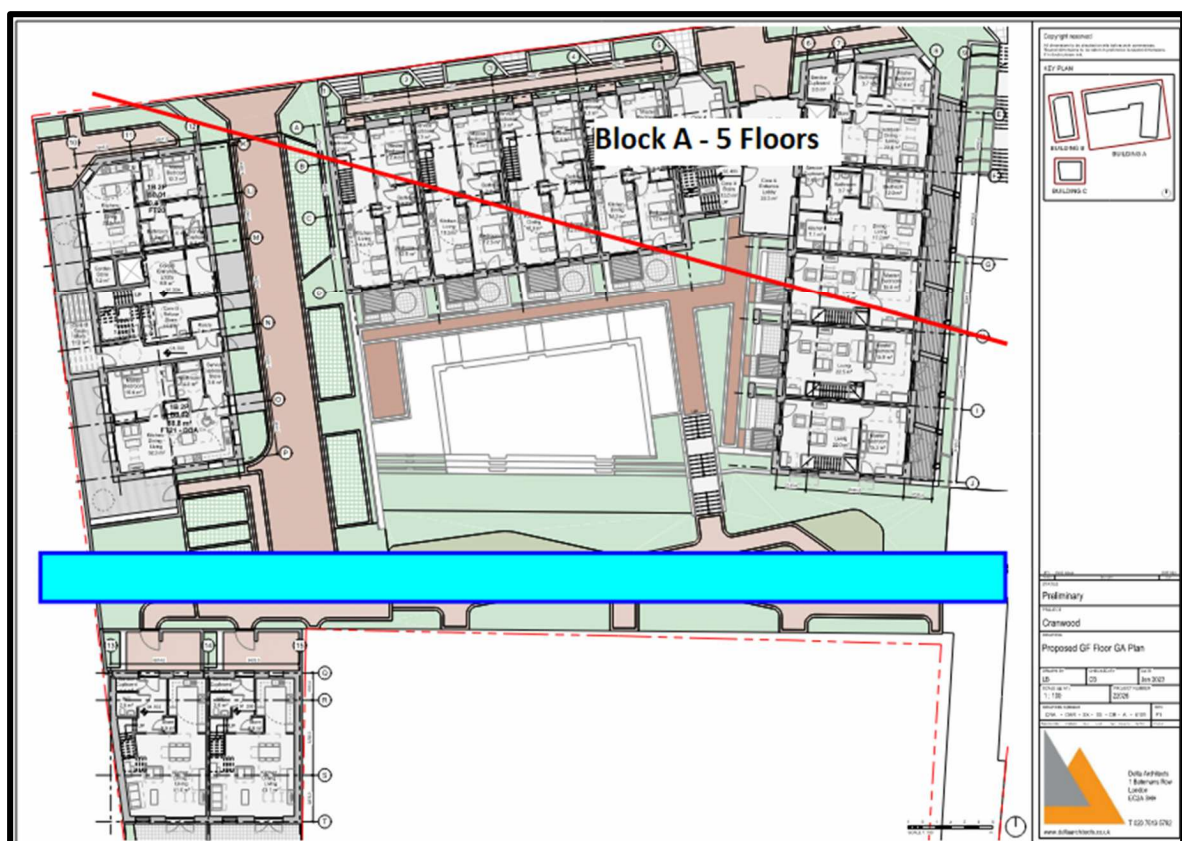


Figure 8 Extract from British Geological Survey Sheet 256 Solid and Drift

A CCTV survey of the 300mm diameter Foul Sewer and a condition survey of the tunnel was carried out by Cable Tracing Services Limited (part of the McAllister Group) in February 2021, in both cases the Thames Water assets were found to be in good condition.

The existing 2/3 storey buildings are to be replaced with a mix of 3, 4 and 5 storey blocks as indicated in the Architects Floor plan provided in Figure 9 below.



From the site investigation works it appears that the original Cranwood House buildings were supported on traditional ground bearing strip and pad foundations which would have transmitted

some loading to the 300mm diameter Foul Water sewer below. For the new buildings it is proposed to support the structure on piled foundations with pile caps and ground beams picking up the columns walls and ground floor slabs (See Figure 10), this arrangement should then result in no loading on the sewer other than that imposed by the overlying soil. To ensure that no loading is transferred to the soil over the sewer by the piles, all piles which fall within a 45 degree cone of influence from the bottom of the pipe upwards will be sleeved to eliminate any skin friction developing between the piles and the surrounding soil. This cone of influence has been superimposed on the MWP Consulting Engineers cross sections on Drawings CRA-MWP-ZZ-00-DR-S-0201 and CRA-MWP-ZZ-00-DR-S-0201, and the extent of sleeving has been indicated on the relevant piles.

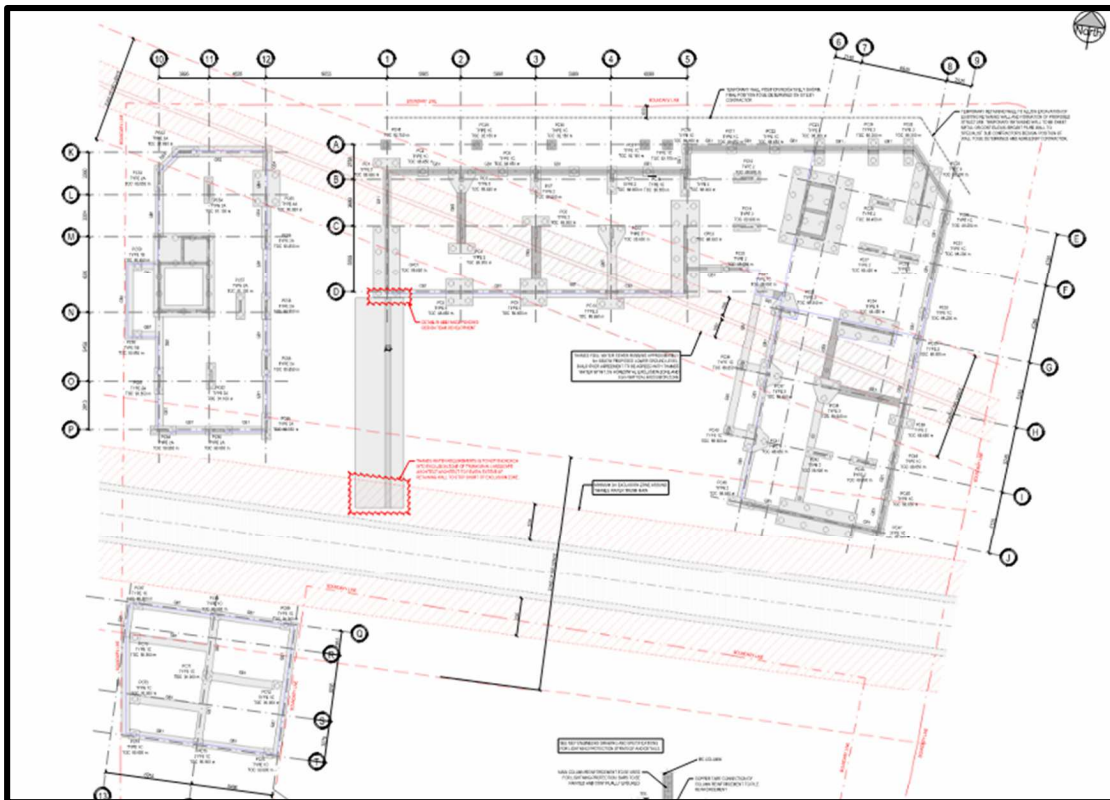


Figure 10 Layout of proposed piles, pile caps and ground beams in relation to the TW Assets. – MWP Drawing CRA-MWP-ZZ-FN-DR-S-1109.

All piles will be non-percussive continuous flight augured piles, which are constructed by drilling a hollow cored auger to the extent of the pile after which the concrete is pumped to the bottom of the bore as the auger is removed, this process ensures that little or no soil loss occurs as the borehole is supported by the auger as the borehole is formed and by pumping the concrete to the bottom the borehole is supported by the wet concrete which will have a higher density than the surrounding soil thus imposing a slightly higher static pressure against the soil than that which the soil is imposing inwards.

However, as a conservative approach the lateral movement as a result of pile installation can be determined using the method from CIRIA Report 760 bearing in mind that this method is strictly only applicable to continuous piled walls where the potential for lateral movement is greater than that likely to be experienced from single isolated piles.

Taking the base of the sewer as 4.90m deep with the nearest pile 1.50m from the pile then the likely movement based on the guidance in CIRIA Report C760 (See Figure 11 below) is as follows: -

Distance from wall/wall depth = $1.5/4.9 = 0.31$ (Note wall depth is intended to represent excavation height for a wall – in this case we are assuming excavation to base of Thames Water asset.)

Horizontal movement/wall depth percentage = 0.025 from graph.

Horizontal movement at invert of sewer = $(4900/100) \times 0.025 = 1.22$ mm. (Lateral movement), considering the pile spacing this would equate to a slope of $1135/1.22 = 1$ in 1100 which is within the capacity of a pipe of this diameter and normal construction tolerances.

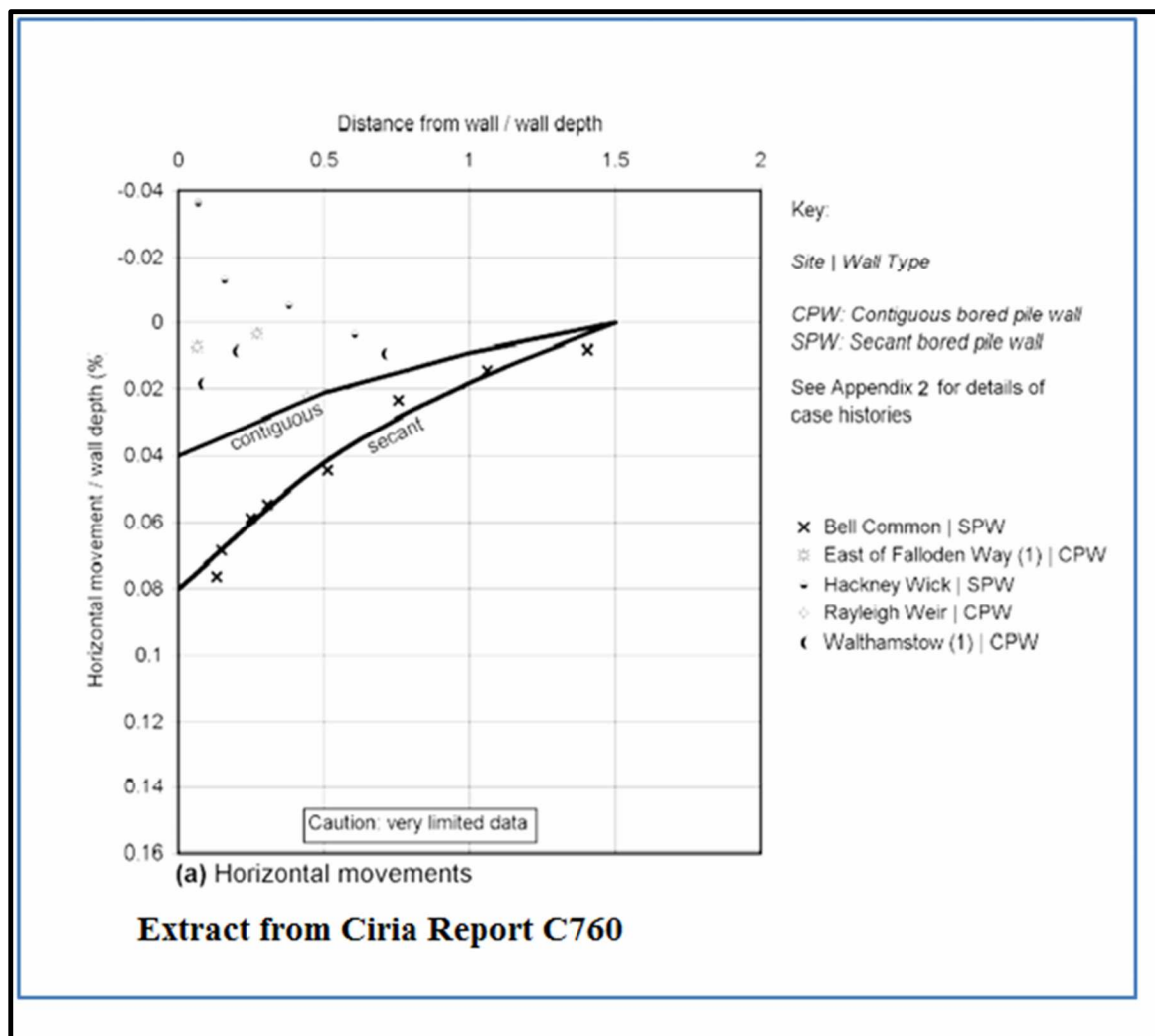


Figure 11 Extract from CIRIA Report 760 - Lateral movement due to pile installation

5.0 Assessment of Construction Loading on the Thames Water Assets.

As stated previously in the permanent condition the loads imposed on both assets will be similar or slightly less than the current loading on the assets. The greatest risk therefore is during construction works by loading imposed by movable plant. The most obvious loading and most invasive is the load imposed by the piling rig which can result in very high track loads during the actual augering operation. While it is possible to exclude the piling operations from immediately above the Tunnel, it would be virtually impossible to do so in all cases above the 300mm diameter Foul Water sewer. However due to the depth of this pipe the impact of the surface load would be greatly reduced at the top of the sewer.

Using the Boussinesq Equation, for a pile track 2.4m long and 0.5m wide with a track pressure of 240kN/m² the increase in pressure at the crown of the pipe would be 5.45 kN/m² (See Figure 12 below) Taking the density of the soil above the pipe at 18 kN/m³ the load imposed on the pipe due to the soil alone would be approximately 88 kN/m² therefore the piling rig would result in a 6% increase in loading.

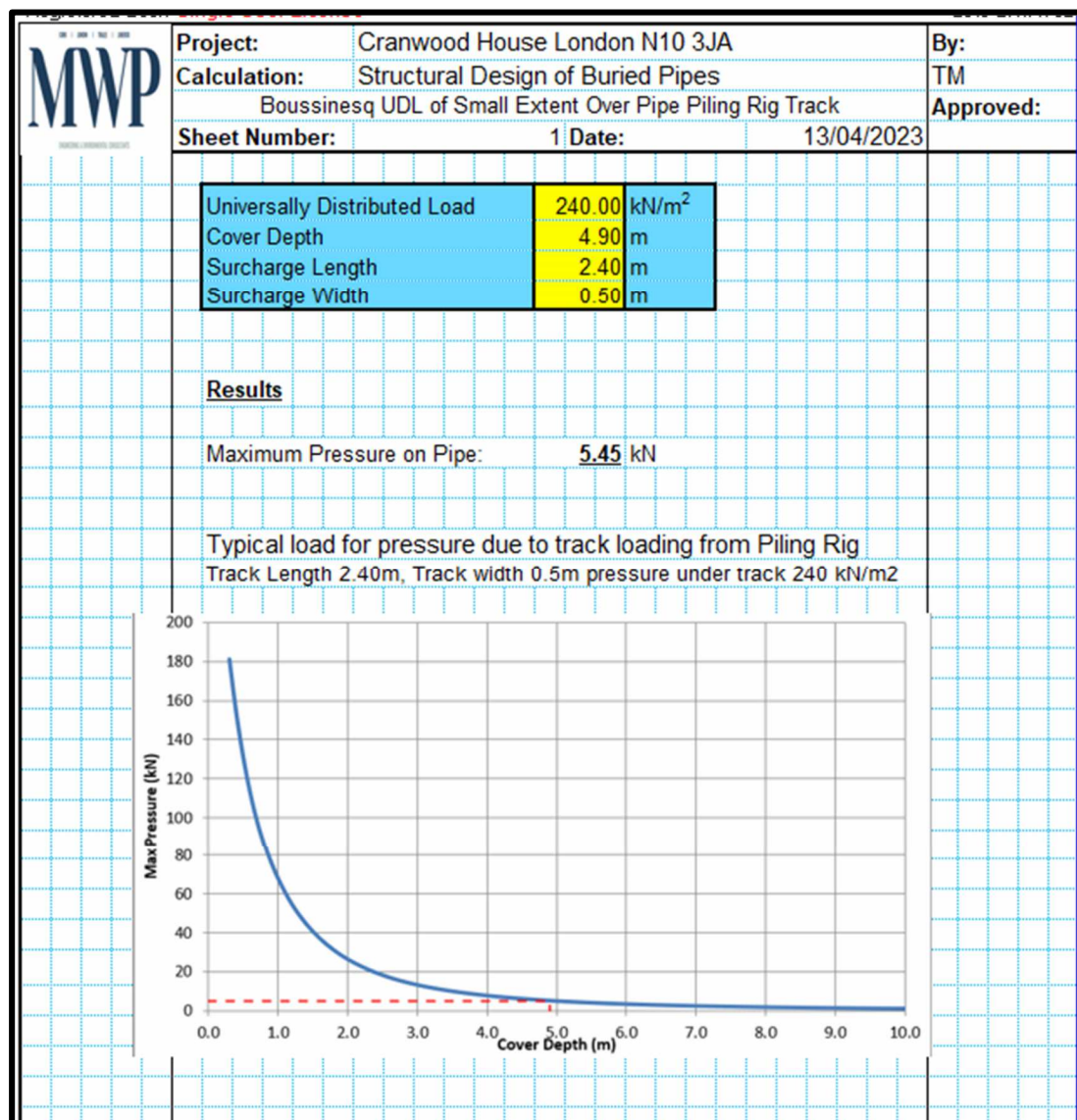


Figure 12 Increase in pressure on pipe due to piling rig.

However, inputting this load into the standard formula for a rigid pipe installed within a trench some reduction is allowed in the vertical load from the soil as a result of side friction between the original soil and the trench fill as indicated in the calculation below, this calculation also included an allowance for light traffic in addition to the piling rig.

MWP	Project:	Cranwood House, Woodside Ave. London N10 3JA	By: TM
	Calculation:	Structural Design of Buried 300mm Pipe - Proposed	Approved:
	Rigid Pipe Structural Design (BS EN 1295-1)		
Sheet Number:	1	Date:	11/04/2023

Pipe & Bedding Detail: PROPOSED CONDITION

Number of Pipes	1
Spacing Between Pipes	10.000 m
Pipe Nominal Diameter	0.300 m
Pipe Outside Diameter	0.360 m
Pipe Crushing Strength	36 kN/m
Pipe Crushing Strength (Override)	52.000 kN/m
Bedding Class	0
Bedding Factor	1.1
Bedding Factor (Override)	1.300
Factor of Safety	1.25

Soil & Trench Details

Soil Type	Maximum for Ordinary Clay
k_u	0.13
k_u (Override)	
k_u^*	0.13
k_u^* (Override)	
Unit Weight of Soil	18.00 kN/m ³
Depth of Cover to Top of Pipe	5.00 m
Width of Trench Base	1.00 m
Excavation Side Slopes	45 degrees
Supported Trench	No
Settlement Deflection Ratio	0.60
Projection Ratio	1.00
Projection Ratio (Override)	0.70
Height of Plane of Equal Settlement (Override)	m

Acceptable

Loading Details

Uniformly Distributed Surcharge Load	5.45 kN/m ²
Concentrated Surcharge Load Type	Light Roads
Concentrated Surcharge Load	1.40 kN/m
Concentrated Surcharge Load (Override)	kN/m

Results

Backfill and Surcharge Load:	51.20 kN/m	Wide Trench - Incomplete Projection
Concentrated Surcharge Load:	1.40 kN/m	
Internal Water Load:	0.56 kN/m	
Total Load:	53.17 kN/m	
Design Strength of Pipe:	54.08 kN/m	Acceptable

Figure 13 Rigid Pipe Design – Wide trench.

As we have no knowledge as to how this pipe was installed and no information on the bedding we have assumed as a worst case that no surround was provided and excavated material was used to backfill the trench, however the compaction of this material is likely to have increased with time therefore it is likely to be better than that which has been assumed in the above calculation.

A similar Boussinesq analysis was carried out for a crane with standard 3.0m by 3.0m pads with an imposed load of 125 kN/m² (see 14 below), assuming this was placed over the tunnel with a cover of 4.20m this would result in an increase of 25.09 kN/m², we consider this load to be excessive and advise that such loading be located so as not to impact the tunnel or 300mm diameter Foul Sewer.

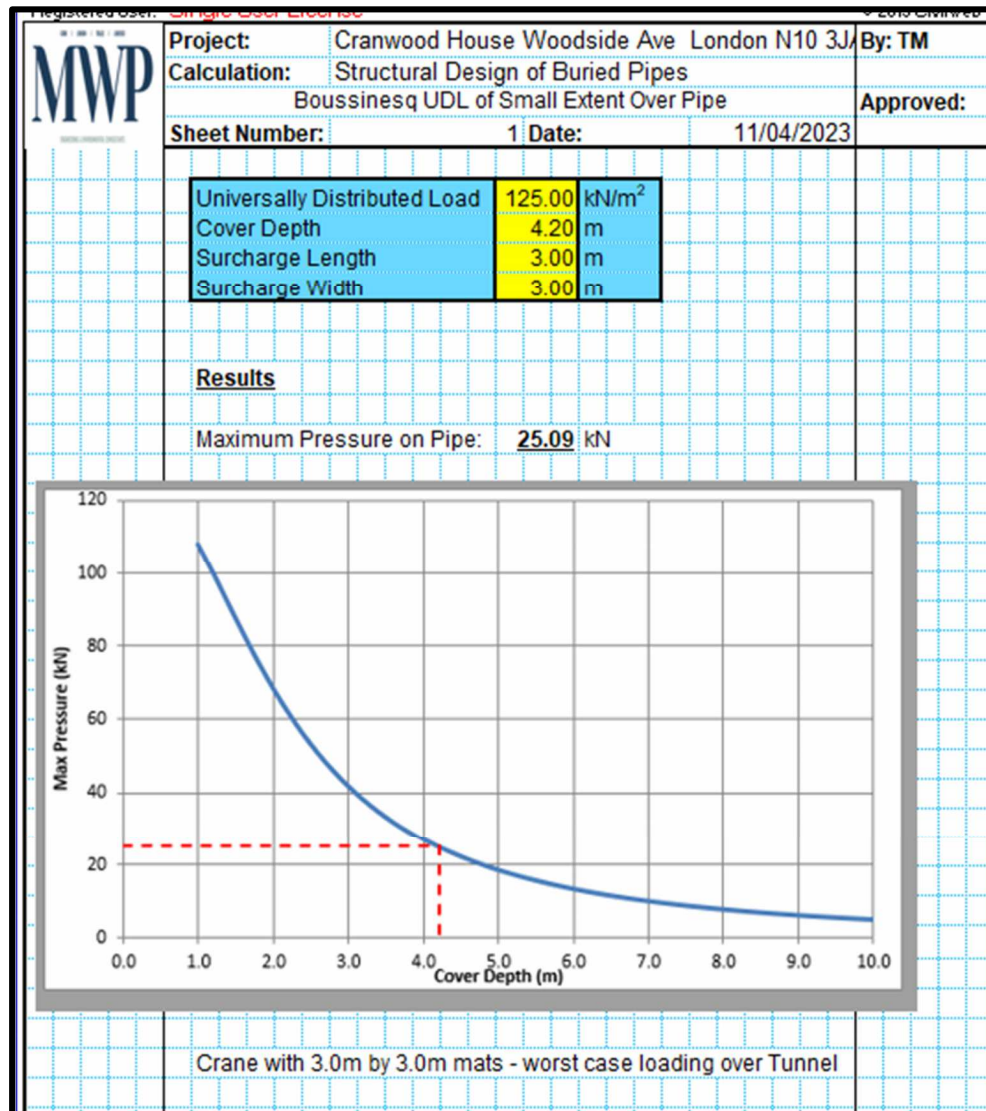


Figure 14 Potential Loading at Tunnel Crown from Crane Mats.

A further analysis was carried out for an abnormal vehicle load, this is modelled on a concrete truck or mobile crane in transit, although we have taken a higher-than-normal wheel loading to provide a factor of safety. The wheel loads used is 40 kN per wheel which equates to a vehicle weighing 48 tonnes. This results in an increase in stress at 4.20m below ground of 7.10 kN/m². This loading is not

over the entire area of the truck but is concentrated in the area of the rear axels as indicated in the stress distribution chart in Figure 16 below.

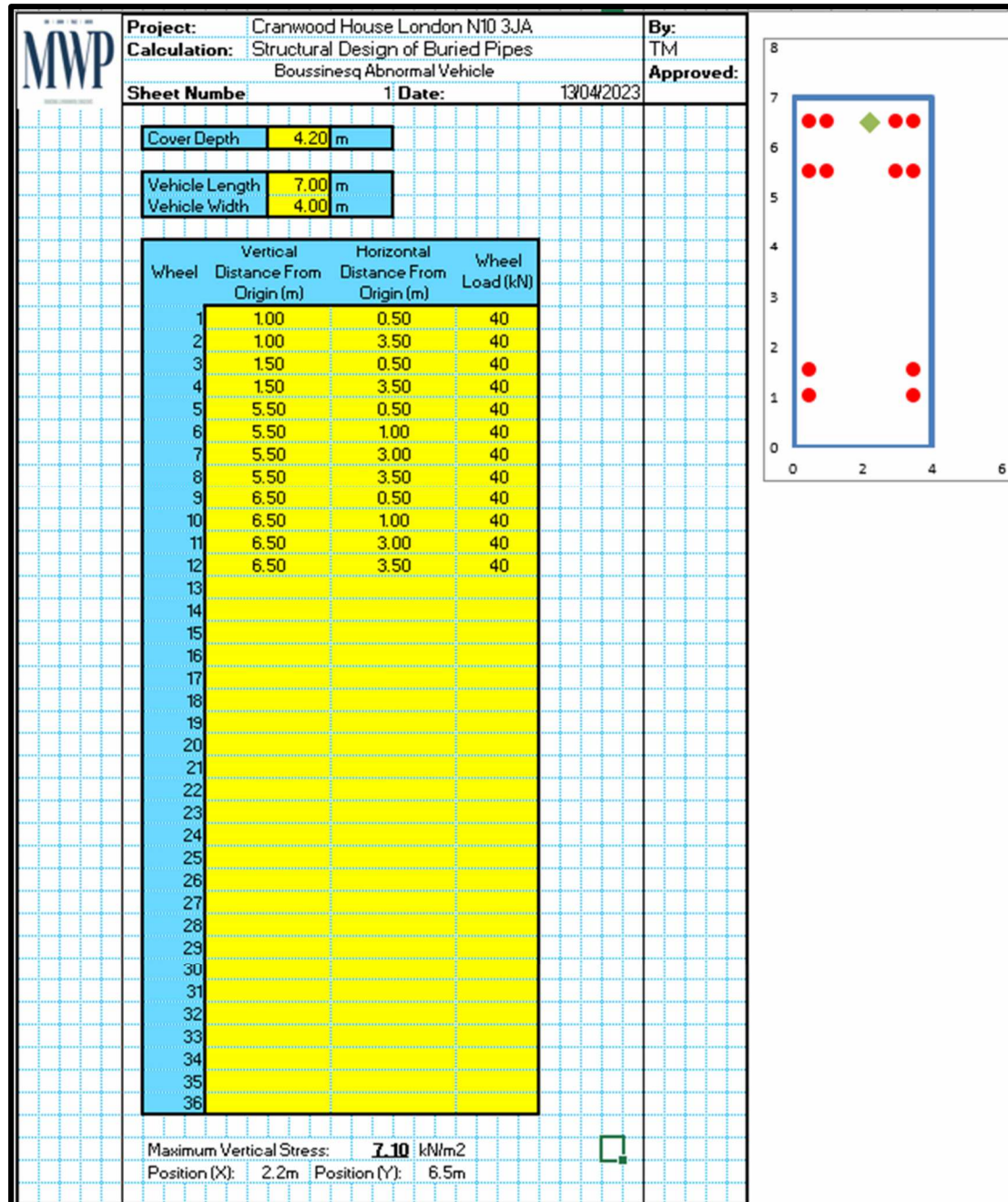


Figure 15 Loading from 12 Wheel Truck weighing 48 Tonne.

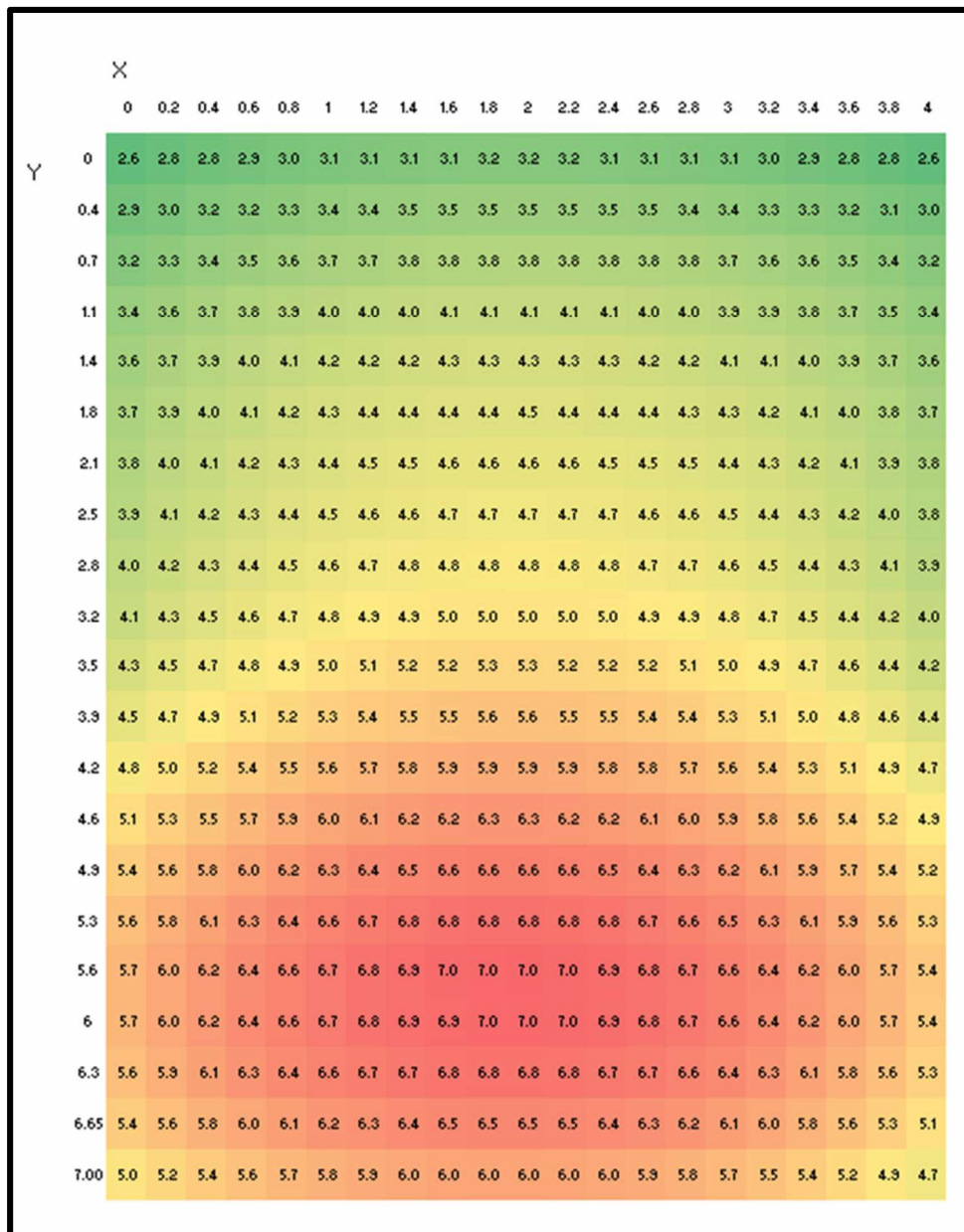


Figure 16 Stress Distribution below Truck at a depth of 4.20m Below Ground.

Based on the above analysis with the exception of the crane mats the expected increase in stress on either the 300mm diameter Foul Water sewer or the tunnel is not likely to be more than 7 kN/m² at the top of either asset, using this figure as the stress increase and considering the loading to be short term an elastic analysis was carried out to determine the likely settlement this loading would cause. The soil parameters used in this analysis are based on the values recommended in the Ground Investigation report. The resulting elastic settlement is 0.87mm we would consider this to be within the range of settlement which would normally occur from seasonal movement within the soil and there for consider that no special precautions are require.

	Project:	Cranwood House London N10 3JA		By:	
	Calculation:	Elastic Settlement Formula		TM	
	Imposed temporary Load of 7 kPa				Approved:
	Sheet Number:	1	Date:	13/04/2023	

Foundation Details		
Foundation Shape	Rectangular	
Foundation Length (X)	4.00 m	
Foundation Width (Y)	4.00 m	
Foundation Depth (Z)	4.00 m	
Foundation Thickness	0.20 m	
Total Axial Load	112 kN	

Soil Details		
Soil Modulus (E_s)	20,000 kPa	
Poissons Ratio	0.3	
Elastic Settlement	0.87 mm	

Figure 17 Elastic Settlement due to additional imposed load on Thames Water Assets.

6.0 CONCLUSIONS AND RECOMMENDATIONS.

Based on the above assessment we consider that the proposal to construct the proposed development at the former Cranwood House site poses a minimal risk to the existing Thames Water Assets which by virtue of the depth to which they are buried provides a high level of protection.

However, all construction work carries risks, particularly if proper safeguards are not put in place and when put in place they need to be followed, we would recommend the following to be included into any method statements: -

No piling to be carried out by a piling rig located above the Thames Water Tunnel. A piling rig traverse the tunnel; however, the Engineer is to check that this does not impose a load greater than 7 kPa at the tunnel crown.

No crane mats to be placed over the tunnel unless the imposed load at the tunnel crown is less than 7 kPa.

The tops of all piles within the 45 degree zone of influence from the invert of the 300mm diameter Foul Sewer or the Tunnel is to be sleeved to below the cone of influence.

Where piles are located within 3.0m of the 300mm diameter Foul sewer, additional precautions are to be put in place to ensure the verticality of the bore, excessive vibration is to be avoided, in the

event of an obstruction being encountered the obstructions should be investigated to determine the nature of the obstruction before proceeding.

Where excessive concrete requirements are encountered within the bore the work should stop and the cause investigated immediately to ensure that no concrete enters the Foul Sewer or the Thames Water Tunnel.

Upon completion of the piling a CCTV survey of the 300mm diameter Foul sewer should be carried out to determine that no damage has been caused.

While it would be normal to carry out levelling and vibration checks it would be difficult to achieve this given the depth of the assets on this site. It may be possible to install targets and vibration monitoring within the tunnel however, this would require regular access to the tunnel which would have to be agreed with Thames Water.

Prepared by

Tim Moynihan BSc MSc C Eng MIEI P. Geol Euro Geol

April 2023

A handwritten signature in dark ink, reading 'Tim Moynihan' in a cursive style.

Malachy Walsh and Partners