

Environmental Statement Addendum – Chapter 12: Hydrology, Hydrogeology,
Flood Risk and Surface Water Drainage
Appendix 12.1
(Part 2 of 2)



Norfolk Partnership Laboratory
Part of the Norse Group

Prepared by:
Norfolk Partnership Laboratory, Norse Eastern Ltd, County Hall,
Martineau Lane, Norwich, Norfolk, NR1 2SG
Telephone (01603) 578389

**Desk Study and Risk Assessment,
Deal Ground and Former May Gurney Site,
Trowse, Norwich,
Norfolk,
104182
April 2023**

Client:
Serruys Property Co Ltd
SPC House
Norwich Road
Lenwade
Norwich
NR9 5SN

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ii) Distribution

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1.0 Introduction

1.1 General

This desk study was carried out at on land known as “The Deal Ground” and the former premises of May Gurney in Trowse, Norwich. (Deal Ground OSGR 624634/307368 May Gurney site OSGR 624528/307005). The site is located approximately 1.80 kilometres to the south east of Norwich City centre. Mr A Serruys instructed Norfolk Partnership Laboratory (NPL) to carry out the work on an email dated 03/04/2023 after acceptance of NPL’s quotation. NPL provides a service within Norse Eastern Ltd.

This investigation fulfils the requirements for a desk study and walkover survey as specified in NHBC Standards, Chapter 4.1 Land Quality - managing ground conditions, January 2019 edition. In addition, a risk assessment has been carried out to the requirements of The Environmental Protection Act Part IIA.

This report is inclusive of a full Envirocheck report, Envirocheck historical maps and historical land use. In addition, consideration is given to the health and safety of construction workers and subsequent residents that may be affected due to any soil contamination.

A large residential development is proposed incorporating a wildlife fenland area and bridge across the River Yare linking the Deal Ground to the north with the former May Gurney site to the south.

Although every effort has been made to give a true assessment of the condition of the site within the constraints of the desk study, it is possible that different ground conditions or contamination may exist in parts of the site that is neither recorded nor visible. The risk of such occurrences should be further reduced by the main investigation if required.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

1.2 Report objectives

The objectives of these works are to review and summarise all previous works undertaken within the site and to assess contamination sources, pathways, and receptors, and to determine whether any contamination may be present either within the site boundaries or just outside the site. The report also assesses the extent to which human health, buildings and services and controlled waters may be affected. If contamination is thought likely to be present, recommendations will be made to ascertain the level of contamination and if these levels are within allowable limits. The report will conclude with a proposal of any further works deemed required.

1.3 Site location

The site is located approximately 1.8 kilometres to the south east of Norwich City centre. (central OSGR 624634/307368).

A site location plan is in Appendix A.

1.4 Site layout

The site can be divided in to two areas which are separated by the River Yare. The north site known as The Deal Ground which is approximately 10 hectares in area and ranges from approximately 0.50m to 4.0m above datum, and the south site the former May Gurney premises which is approximately 2.5 hectares in area relatively level and around 2.0m above datum.

1.5 Planning application

The site area falls within three local authorities:

- a) Norwich City Council (Deal Ground to the north) Planning ref 12/00875/O with subsequent additions and amendments.
- b) Broads Authority (Bridge over the River Yare linking the two sites)
- c) Broadland District & South Norfolk Council (May Gurney site to the south) Planning ref 2011/O152 with subsequent additions and amendments.

2.0 Desk Study

2.1 Description of site and surroundings

A walkover survey was undertaken on 12 April 2023 by Mr I Brown, Mr S Berwick, and Ms J Price of Norfolk Partnership Laboratory.

The Deal Ground (north site)

Access to the Deal Ground is via the Tarmac asphalt plant entrance off Bracondale (C202) on the east side of the bridge which crosses the Norwich to London railway line. The site access road continues past the Tarmac entrance on the east side of the asphalt plant and at the northern end where the site widens turns eastward and terminates at the entrance to Carrow Yacht Club which is located on a narrow parcel of land at the confluence of the River Wensum and River Yare. The Club has right of way access across the Deal Ground site. The road is approximately 800m in length. The Deal Ground is bounded by the River Wensum to the north and the River Yare to the east with the asphalt plant and railway to the west. A small fenced off area housing gas valves encroaches on the site just to the west of the road at the southern end of the site. The majority of the industry was located in the northern area. All of the buildings have been demolished and the concrete oversite removed leaving only the road to the Yacht Club and a large open area comprising unbound aggregate surfacing. A number of spoil heaps were present in the north west corner with a spoil heap of broken cement board and aggregate placed on polythene sheeting. Cement board fragments were also present within the surface made ground. There is also below ground drainage infrastructure and standing surface water in this north western portion of the site.

A small number of unidentified blue 45 gallon drums, tyres and an engine part were present adjacent to the river towards the north eastern corner of the site. This could have been a abandoned raft due to its proximity to the river.

The majority of the land to the east and south of the access road and to the west of the River Yare is a mix of grass, scrub, brambles, and self-seeded Silver Birch trees. At the time of the walkover the scrub and smaller trees were being cleared. A strip of this land adjacent to the river and leading down to a timber drying bottle kiln (annotated "Destructor" on the historical maps) does appear to comprise of Made Ground with evidence of large concrete blocks, bricks, metal, and plastic items.

South of the Kiln the study area narrows with the majority of the land waterlogged fen designated as a County Wildlife Site (CWS). Between the access road and fen, the land is a mix of grass, brambles and scrub with an area undergoing treatment for Japanese Knotweed. Some of this land comprises of Made Ground particularly at the southern end where there was moss covered bonded brick and concrete.

There are numerous services across the site including below ground electric cables, steel gas main, pumping rising mains and BT cables.



Photograph 1 : Southern end of the site looking to the south towards entrance/exit. Asphalt plant on the right side (west).



Photograph 2 : Land between access road and fen to the south of the site before second gated access. Asphalt plant to the west.



Photograph 3: Grass scrub and brambles between access road and fenland before second gated access.



Photograph 4 : Second gated access to the Deal Ground site.



Photograph 5 : Off site fenced gas valve compound.



Photograph 6 : Made Ground on land between the access road and the fenland.



Photograph 7 : Treated area of Japanese Knotweed.



Photograph 8 : Treated area of Japanese Knotweed.



Photograph 9 : Northern area where site widens. Location of the historical industrial works.



Photograph 10: North western portion of the site with cement board sheets and fragments.



Photograph 11: Spoil heaps on the north west portion of the site.



Photograph 12 : View to the north east corner



Photograph 13 : Unidentified barrels, and tyres



Photograph 14 : North eastern corner and access to Carrow Yacht Club



Photograph 15 : View of the northern portion of the site from the east side looking to the west.



Photograph 16 : Potential made ground strip close to the River Yare.



Photograph 17 : Potential made ground strip close to the River Yare.



Photograph 18 : Timber drying Bottle Kiln.

May Gurney (south site)

The former May Gurney site is accessed from The Street (C202) at the approximate midpoint along the southern boundary on to an asphalt road which is approximately 100 metres in length and ends roughly in the middle of the site. The western and northern site boundary is formed by the River Yare with the boundary on the east side a tributary of the River Yare. The surfacing on the site comprises intact asphalt and concrete on the western half with unbound aggregate and topsoil on the eastern half with some remnants of former structures. The buildings which remain on the site are located along the western boundary and comprise a two storey brick and tiled former Public House which was converted to offices with single storey brick and tiled buildings to the rear. These are arranged in a “C” shape and located in the south west corner. All had been vandalised with almost every window broken and internal fixtures and fittings destroyed. An asphalt car park is to the north of this cluster of buildings with a bunded heating oil tank close to the western boundary. Located along the boundary to the north of the heating oil tank were numerous scrap metal items mainly consisting of external steel staircases. Another large office building is present to the north of the car park. This building has a brick ground floor with a steel clad second floor addition and had also been vandalised. A small fenced off substation is located just to the west of the building. To the north the site is concrete covered with two bunded heating oil tanks located close to the northern site boundary,(9000 litre and 100000 litre). At the time of the walkover removal of trees and scrub was underway close to the banks of the Yare and the tributary on the east side.



Photograph 19: Office buildings in the south west corner.



Photograph 20: Heating oil tank and scrap to the north of the buildings in the south west corner.



Photograph 21: Heating oil tank with bund full of water.



Photograph 22: Scrap metal close to the western boundary.



Photograph 23: Office building



Photograph 24 : Substation to the west of the northerly office building



Photograph 25 : Land to the north of the office building. Two large diesel tanks close to the northern boundary.



Photograph 26: View to the north east



Photograph 27: 9000 litre bunded fuel tank



Photograph 28: 10000 litre bunded fuel tank close to northern boundary



Photograph 29: North eastern portion of the site.



Photograph 30 : View to the south, of the eastern half of the site.



Photograph 31: View along the eastern boundary from the north east corner looking to the south

2.2 Desk study research undertaken

In accordance with the recommendations of Chapter 4.1 of NHBC Standards desk study information has also been gathered from numerous sources. These are summarised below:

- Institute of Geological Sciences, Hydrogeological Map of Northern East Anglia, Sheet 1 Regional Hydrological Characteristics and Explanatory Notes.
- Institute of Geological Sciences, Hydrogeological Map of Northern East Anglia, Sheet 2 Chalk, Crag, and Lower Cretaceous Sands: Geological Structure.
- Institute of Geological Sciences - British Regional Geology East Anglia and Adjoining Areas (Fourth Edition) 1961.
- British Geological Survey, East Anglia Sheet 52N00, Solid Geology; Scale 1:250,000.
- British Geological Survey, East Anglia Sheet 52N00, Quaternary; Scale 1:250,000.
- BGS Geology Sheet number 161
- Ordnance Survey Digital Map.
- Ordnance Survey Maps 1882, 1885, 1886, 1907, 1908, 1914, 1920, 1928, 1929, 1938, 1951, 1957, 1958, 1959, 1967, 1970, 1979, 1989, 1994, 2000, 2023.
- BRE BR211 Radon: Guidance on protective measures for new dwellings.
- BRE SD1 Concrete in aggressive ground.
- BS 10175:2011 – Investigation of potentially contaminated sites.
- Department of the Environment Industry Profiles.
- CIRIA C665 Assessing risks posed by hazardous ground gases to buildings, 2007.
- BS 8485:2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

2.3 Past and current activities at the site

On the 1886 OS map the north site comprises of enclosed land and rough pasture. There appears to be a track present running centrally through the site. A Timber Yard is annotated in the north west corner adjacent to the river. Many drainage ditches are present to the west of the River Yare. The railway line is present to the west with cattle pens adjacent to the south west. A cluster of buildings are present in the south west corner of the southern site adjacent to the carriageway and the river with the remainder undeveloped with a drainage ditch crossing the site from east to west. A sewage works is adjacent to the river on the west side.

On the 1914 OS Map six large rectangular buildings are present at northern end of the north site annotated Timber Yards. The Great Eastern Railway is annotated to the west. A single rail track passes through a tunnel from the west and continues through the site. The land to the east is annotated liable to flood. The southern site is unchanged with the exception of the drainage channel along the east boundary which has been straightened.

No significant changes are shown to the north site on the 1928 OS Map which remains annotated as Timber Yards. The railway line to the west is annotated the LNER Cambridge to Norwich Main Line. More development is apparent on the railway land to the north of the river. Minor changes have occurred to the southern site with the addition of four more buildings on the west side close to the river to the north of the existing cluster.

On the 1938 OS map more tracks are shown on the northern site some of which lead to two small structures annotated "Destructors". One of these is in the location of the bottle kiln presently on site which was used for drying green timber. The engineering railway land north of the river continues to expand. The railway to the west is annotated London and North Eastern Railway. Further expansion is apparent on the southern site with additional larger buildings shown on the west side and adjacent to the river. Electricity cables cross the undeveloped part the southern site and the fenland area on the northern site.

On the 1958 OS map further changes have occurred on the northern site. The building which was located at the eastern end of the site is no longer present. The structure in the north west corner has decreased in size with an additional row of much smaller buildings shown just to the east. A new large rectangular building is present to the south of the structure annotated "Works". To the east of the site adjacent to the river two areas of earthworks are shown likely to be tipped inert waste. Development has also occurred on the southern site with many new structures shown centrally and in the south east corner. Two of the buildings are annotated Warehouse with ramps, crane and tanks also annotated. A Public House, Post Office and Smithy Cottage are all annotated in the south west corner of the site adjacent to The Street.

On the 1968 OS map the hardstanding areas are clearly defined on the northern part of the site with the remainder shown tree and shrub covered. The two filled areas have amalgamated in to one larger area adjacent to the River Yare. Further development has occurred on the southern site with additional large buildings shown in the north

east corner and adjacent to the river on the north side. The site is annotated Transport Depot and Civil Engineering Depot.

On the 1994 OS map only two buildings remain central to the northern area with the site annotated "Works". The filled area is detailed to the east. A gas valve compound is annotated to the south of the site on the west side. The southern site is annotated "Depot" with the buildings present across the site.

Both the north and south site appear unchanged on the 2000 1:10000 OS map. The 2023 OS map shows the northern have cleared of all structures as is the southern site with the exception of the south west corner.

2.4 Intended future use of the site

A significant residential development is proposed incorporating a wildlife fenland area and bridge across the River Yare linking the Deal Ground to the north with the former May Gurney site to the south.

2.5 Planning applications or permissions at the site

The site area falls within three local authorities:

- a) Norwich City Council (Deal ground to the north) Planning ref 12/00875/O with subsequent additions and amendments.
- b) Broads Authority (Bridge over the River Yare linking the two sites)
- c) Broadland District & South Norfolk Council (May Gurney site to the south) Planning ref 2011/O152 with subsequent additions and amendments.

2.6 Geology

The geology of the region may be summarised as follows:

Recent : Alluvium
: Peat
: River Terrace Deposits

Cretaceous : Upper Chalk

Upper Chalk is a soft white or off white limestone that contains flints. Chalk was deposited in a warm sea close to a low lying landmass that remained free from the deposition of detritus for a long period of time. The chalk dips at a very shallow angle to the east. The Hydrogeological Map of Northern East Anglia (Sheet 2) indicates that the Chalk surface is around Ordnance Datum in the study area.

The materials known as **First and Second Terrace** are alluvial materials laid down after the Pleistocene glaciation as the glacial and pre-glacial channels became infilled. These comprise mainly of gravels and sands and have subsequently been left above the level of the river as it has eroded its channel.

Alluvium is the material laid down in its channel and on the flood plain by rivers, streams, or other body of running water. This material is generally silt, sand, or clay. The presence of gravels represents times of flood. Where still conditions prevail then the growth of plant material may occur in or near the river channel, this facilitates the development of peat as this material dies and is buried.

Peat is a partially decomposed mass of vegetation which accumulates in wet ground conditions such as marshes and bogs, and the fringes of shallow lakes. The deposit is extensively developed along the valleys of the rivers Waveney, Little Ouse, Thet and Tas drainage systems. Within these valleys the peat is generally less than 2.0 metres thick and interdigitates with and passes laterally into alluvium. The peat is commonly sandy, especially in narrower valleys where hillwash has contributed to the deposit. Patches of the peat also occur as the youngest deposit of depressions infilled with Flandrian mere deposits.

A geology report can be found in Appendix C.

2.7 Hydrogeology and Hydrology

According to the Regional Hydrogeology Map of Northern East Anglia, the Chalk is the principal aquifer for the area. The estimated minimum hydrostatic level of the Chalk water table in the vicinity of the site is approximately at Ordnance Survey Datum.

The northern Deal Ground site is between approximately 1 and 4 metres above Ordnance Survey Datum. Therefore, the groundwater is thought to be approximately 1 and 4 metres below the site.

The southern May Gurney site is approximately 2 metres above Ordnance Survey Datum. Therefore, the groundwater is thought to be approximately 2 metres below the site.

The northern part of the Deal Ground site and the land along the eastern boundary is within the Environment Agency Flood Zones 2 & 3.

The May Gurney site to the south is within the Environment Agency Flood Zone 2.

The Aquifer designations are principal for the bedrock Chalk and Secondary A for the Alluvium deposits.

The site is within the Environment Agency groundwater source protection inner zone (Zone 1).

The BGS flood data map indicates that there is potential for groundwater flooding to occur at the surface.

The River Wensum and Yare and a tributary of the Yare form the boundaries to the site.

The fenland to the east is a Country Wildlife Site and nature reserve.

2.8 Consultations with the local authority

All authorities involved have consulted on the proposed development of the site with numerous planning references on the Norwich City Council planning portal and the South Norfolk planning portal.

2.9 Consultations with the Environment Agency

The Environment Agency have consulted on the development.

2.10 Consultations with other appropriate bodies

No other bodies have been consulted during the compilation of this report.

2.11 Review and summary of previous reports

Contamination Desk Study Report ref 151139 : Proposed residential development at Deal Ground (north site) and May Gurney (south site) : The Street, Trowse, Norwich by Plandescil Consulting Engineers dated August 2010.

The report summarises previous investigations at the site which are listed below:-

Deal Ground north Site

- August 1990 intrusive site investigation by May Gurney
- August 1992 intrusive site investigation by May Gurney
- August 1997 intrusive site investigation by May Gurney

The summary of these historical investigations concluded the presence of Made Ground deposits in the northern area and in the south west overlying Alluvium and River Terrace sands and gravel deposits. The bedrock Chalk was encountered at between 7.25m and 9.20m below ground level.

The area to the north included granular fill material which was laid down to facilitate the Timber Yard. Window Sample holes confirmed made ground deposits approximately 2.0m thick in places. The conservation area had not been filled. Permission was granted by NCC for the tipping of waste materials excluding organic of liquid waste.

The potential contamination sources were :

Onsite

Timber Yards
Sawmills
Factory Works including print and bottle works
Mineral extraction with possible tipping.

Offsite

Railway land to the west
Factory Works to the west
Road Haulage to the west

May Gurney south site

- March 2005 interpretive geotechnical and environmental report by May Gurney
- March 2005 Environmental Risk Assessment by May Gurney which concluded the Lead had no impact on groundwater. Elevated TPH and PAH in the Made Ground were minimal risk to groundwater.

- November 2006 Environmental Constraints Report by Buro Happold. This report considered all the previous investigations including the utilities site north of the River Wensum. It concluded that it would be prudent to carry out an additional unexploded ordnance study at the site due to High Risk based on the presence of a major railway line. Further detailed ground investigation was recommended beneath the proposed development to assess the degree of contamination.
- February 2007, Desk Study, May Gurney. In April 2005 the Environment Agency recommended groundwater and river water testing for the potential of chlorinated solvents which had been found in local boreholes. The site was identified as one of seven industrial sites highlighted as a potential source. The report was undertaken voluntarily and following further investigation a third of the site along the southeast boundary was signed off as no chlorinated solvents were found. As part the investigation a Desk Study was undertaken which revealed historical uses including plant and transport workshop, car dealership showroom and petrol filling station including two underground tanks decommissioned in 1996 and garden machinery centre.
- February 2008 Factual Report May Gurney. Boreholes 102/102/103 and WS01 to 09 drilled (WS01/03/08 wells installed) to test soil and groundwater for the presence of chlorinated solvents notably Trichloroethane. No interpretation of the results was made.
- August 2008 Site Investigation and groundwater risk assessment Merebrook report. Chlorinated solvents were not detected in significant quantities in any samples. BTEX and hydrocarbons were detected. Correspondence from the EA to SNDC advising there was no reason to designate the site as a “special site”. An investigation of the impact of contamination on the chalk aquifer and deeper groundwater was carried out. Three boreholes were drilled terminating at between 21m and 25m. Some BTEX was encountered but the distribution was variable suggesting multiple sources. The main source was considered to be the USTs in the vicinity of WS08 and BH103.
- November 2009 Contaminated land assessment Merebrook. (NE area of May Gurney site). Boreholes and trial pits were drilled across this north east parcel of land. Fifteen samples were tested for contamination and gas monitoring was also undertaken in October/November 2009. Elevated levels of Arsenic, Lead and Hydrocarbons were present in some samples. Gas monitoring indicates an Amber 1 situation which would require gas protection measures.

The potential contamination sources were :

Onsite

Warehouses

Tanks

Transport Depot and Road Haulage

Waste management (transfer site)

Electrical substation

Garden Machinery sales and service.

Offsite

Railway land to the west of the river
Road Haulage (north of river)
Factory/works (north of river)

The Plandescil Contamination Desk Study proposed further investigative works. Boreholes and Window Samples were recommended with installations for groundwater sampling and gas monitoring. The use of existing boreholes should also be employed. Trial pits were also recommended, and testing suites based on zoned areas. The Japanese Knotweed will require specialist treatment to eradicate it. It is also anticipated that soil remediation will be required across the north and south sites.

Site Investigation including Quantitative Risk Assessment, The Deal Ground, Trowse Norwich ref : 102029 dated August 2021 by Norfolk Partnership Laboratory (NPL)

This investigation was carried out on the former industrialised northern portion of the Deal Ground site (north site) and addressed the further work recommended in the Plandescil Report and supplementary work suggested by Norwich City Council following the removal of the hardstanding over the majority of the site.

Historical land use indicated that there had been varied industrial use associated with the Deal Ground. A number of potential pollutants are identified in the Department of the Environment Industry profiles. No profile was considered to be directly applicable to this site. After visual examination and studying information from the previous report the following have been identified as potential pollution sources.

- ACM materials present in the historical buildings
- Former Timber Yard/timber treatment and sidings
- Former Sawmill
- Former factory printworks
- Former factory bottle works
- Historical mineral extraction and infilling
- Migration of possible ground gases from off-site infilled land and historic industrial activities
- Offsite Railway to the west
- Offsite factory

On 17th and 18th June 2021 19 window sample holes were drilled to a maximum depth of 5.00 metres.

A number of pollution prevention measures were required which were :-

precautions whilst drilling in the north west corner of the site where the surface soils were known to contain Asbestos.

No walkover or investigation where Japanese Knotweed has been identified. These areas are clearly signed and fenced off.

No material was removed with the exception of samples for testing. Due diligence was employed to prevent any possible cross contamination of material. Window sample holes which had no installations were backfilled with bentonite.

Soil was tested from all window sample locations (1 to 19) and at multiple depths in most cases. The testing regime included a standard suite of tests Suite SB, Speciated TPH, Asbestos Screening, VOC's and SVOC's. Groundwater was sampled from WS01 to WS07 inclusive, the testing regime included a standard suite of tests, Suite WB, Speciated TPH, VOC and SVOC's. A sample from the River Wensum was also analysed for the same contaminants of concern.

Made Ground was present as the surface material in all but three of the locations. The thickness ranged from 0.15 metre to 1.40 metres.

Alluvial deposits were present below the surface deposits in all but five locations. The deposit was encountered at depths between ground level and 0.75 metres. The base of the deposit ranged from 0.85 metre to 2.10 metres.

Peat was positively identified in all but three of the window sample holes. The surface of the Peat was recorded at depths ranging from 0.45 metres to 1.40 metres. The Peat was proven at depths between 0.80 metre and 4.85 metres.

River Terrace Gravels were identified in all of the investigations. The base of the deposit was not proven at a maximum depth of 5.00 metres.

No bedrock Chalk deposit was identified during the investigation. A layer of reworked chalk was encountered between 2.80 metres and 3.50 metres in WS15.

Groundwater monitoring was carried out over a period of approximately one month in the Window Sample holes with installations placed in them. The minimum depth below ground level recorded was 0.20 metre in WS01 and the maximum depth was 1.50 metres in WS06. Both the River Wensum and the River Yare are tidal.

All of the soil results were found to be below the C4SL's, Atkins ATRISK and LQM/CIEH S4UL's threshold values for residential with the consumption of home grown land use produce, with 1% soil organic matter.

One sample had Chrysotile fibrous asbestos material present.

Two rounds of groundwater sampling were carried out from the seven window sample holes. A sample was also taken from the River Wensum adjacent to the site at a downstream location.

The River Wensum sample showed no elevated levels of contaminants of concern.

The water samples generally revealed metal results above the levels noted in the river sample, but none were significantly elevated. No VOC or SVOC were above levels of detection. Speciated TPH results were slightly elevated during the initial round of sampling in WS01, WS02, WS05, WS06 and WS07. The second round of results were much improved with only WS04, WS05 and WS06 recording values above levels of detection. These results were as follows:

WS04 Total TPH 1680ug/l

WS05 Total TPH 372ug/l

WS06 Total TPH 63ug/l

The gas monitoring was carried out over a period of one month. The maximum Carbon Dioxide reading was 4.1% in WS04. Although tested for no Methane or flow was recorded. Using CIRIA report C665 the site can be classified as NHBC traffic light situation GREEN. This is indicative of a negligible gas regime and gas protection measures are not considered necessary.

Based on the findings of the report the following potential contamination sources were all considered to have a low risk to human health, buildings and services and controlled waters. Low Risk (considered conceivable but unlikely).

Former Sawmill

Former Factory Printworks

Former factory bottle works

Historical mineral extraction and backfilling

Migration of ground gases from off site infilled land and historic industrial activities

Off site Railway land to the west

Off site factory

A high risk (considered probable ie about 50% chance) remained to the construction worker for the ACM via surface soil linkage on the land in the north west corner of the site. A medium risk was present to the resident and trespasser via the same linkage.

The former timber yards were thought to pose a Medium Risk to the construction worker via a subsurface soil linkage through a direct contact pathway.

It was recommended that no further intrusive investigation for contamination purposes was required on this northern part of the site until a detailed final design is produced.

An area of Japanese Knotweed is present on the site. It is recommended that an action plan to eradicate this invasive weed is put in place prior to the current years seeding.

The area of asbestos contamination in the north western corner of the site is to be remediated and reported separately. It is recommended that at this time the area surrounding WS18 should be further investigated to remove the risk.

3.0 Identification of potential contaminants of concern and source areas

As outlined in the many reports summarised above the north site has had an industrial past history associated with the Colman's of Norwich which also includes potential landfilling on the eastern boundary. The former May Gurney site to the south has also had a variable industrial history with land uses including Civil Engineering Depot and Transport Depot with fuel tanks also present on the site. From reviewing these reports and the intrusive investigations, and testing which has been undertaken coupled with information from the recent walkover survey, the following potential contamination sources and associated risks remain relevant to the site presently.

- i) Made ground from historical land use (north site)
- ii) ACM in soils in the north west corner (north site)
- iii) Historical landfilling to the north east and east (north site)
- iv) Unidentified 45 gallon drums to the north east (north site)
- v) Japanese knotweed to the south east of the site (north site)
- vi) Made Ground from various industrial land uses (south site)
- vii) Above ground 9000 and 10000 litre bunded fuel tanks (south site)
- viii) Bunded heating oil tank west side to rear of office building (south site)
- ix) Underground fuel storage tanks south of the site (south site)
- x) Generation of ground gas from Made Ground and/or organic soils

These have a variety of potential pollution linkages.

4.0 Risk Assessment

4.1 Conceptual Model

The known or perceived sources of contamination and pollution linkages are assessed in this section. The conceptual model is realised here in tabulated form.

4.2 Sources of contamination

As outlined in the many reports summarised above the north site has had an industrial past history associated with the Colman's of Norwich which also includes potential landfilling on the eastern boundary. The former May Gurney site to the south has also had a variable industrial history with land uses including Civil Engineering Depot, car dealership with fuel filling station and Transport Depot with fuel tanks also present on the site. From reviewing these reports and the intrusive investigations, and testing which has been undertaken coupled with information from the recent walkover survey, the following potential contamination sources and associated risks remain relevant to the site presently.

- i) Made Ground from historical land use (north site)
- ii) ACM in soils in the north west corner (north site)
- iii) Historical landfilling to the north east and east (north site)
- iv) Unidentified 45 gallon drums to the north east (north site)
- v) Japanese Knotweed to the south east of the site (north site)
- vi) Made Ground from various industrial land uses (south site)
- vii) Above ground 9000 and 10000 litre bunded fuel tanks (south site)
- viii) Bunded heating oil tank west side to rear of office building (south site)
- ix) Underground fuel storage tanks south of the site (south site)
- x) Generation of ground gas from Made Ground and/or organic soils

4.3 Pollution Linkages

Each of the potential contaminants may have a number of pollution linkages. Each of these linkage types has a number of potential pathways.

- i) Surface soil linkages
 - a) Direct contact ingestion or absorption
 - b) Indirect contact ingestion or absorption
 - c) Leaching to groundwater
- ii) Subsurface soil linkages
 - a) Direct contact ingestion or absorption
 - b) Indirect contact ingestion or absorption
 - c) Leaching to groundwater
- iii) Surface water linkages
 - a) Direct contact ingestion or absorption
 - b) Indirect contact ingestion or absorption
 - c) Percolation to groundwater
- iv) Groundwater linkages
 - a) Direct contact ingestion or absorption
 - b) Indirect contact ingestion or absorption
- v) Airborne linkages
 - a) Vapour intrusion into confined / indoor spaces
 - b) Inhalation or absorption of particulates
 - c) Inhalation or absorption of volatile compounds

4.4 Receptors

A number of potential receptors exist. These can be broadly grouped as

- i) Construction Worker
- ii) Future Resident
- iii) Trespasser
- iv) Local population
- v) Flora and fauna
- vi) Buildings
- vii) Surface Water
- viii) Groundwater

For each source, the linkage type, pathway and potential receptors can be identified. A level of risk if no action is taken can then be assigned to each of these linkages. The level of risk has been divided into six categories as follows

Very Low Risk – Considered very unlikely or impossible

Low Risk – Considered conceivable but unlikely

Medium Risk – Considered possible but unusual

High Risk – Considered probable ie about 50% chance

Very High Risk – Considered that it is to be expected to happen

Certainty – Considered that it will happen

Note: These risks are related to the probability of an event happening. They do not relate to the severity of the effects on human health or flora and fauna nor the financial consequences if the event should happen.

4.4.1 Made Ground from historical land use (north site)

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Surface water	Low
	Indirect contact ingestion or absorption	Resident	Low	
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
		Indirect contact ingestion or absorption	Resident	Low
		Leaching to groundwater	Local population	Low
		Flora and fauna	Low	
		Construction Worker	Low	
		Groundwater	Low	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Surface water	Low
		Percolation to groundwater	Local population	Low
		Flora and fauna	Low	
		Groundwater	Low	
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Local population	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Groundwater	Low
		Indirect contact ingestion or absorption	Local population	Low
		Flora and fauna	Low	
Airborne linkage	Inhalation of particulates	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
	Inhalation of volatile compounds	Inhalation of volatile compounds	Construction Worker	Low
			Resident	Low
			Trespasser	Low
			Flora and fauna	Low
			Local population	Low
Vapour intrusion into indoor spaces	Vapour intrusion into indoor spaces	Resident	Low	
		Local population	Low	

4.4.2 ACM in north west corner (north site).

Linkage type	Pathway	Receptor	Risk
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Very High
		Resident	Very High
		Trespasser	Very High
		Flora and fauna	Low
		Direct contact	Surface water
	Indirect contact ingestion or absorption	Resident	Very High
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Very High
		Resident	Very High
		Flora and fauna	Low
		Direct contact	Buildings and services
	Indirect contact ingestion or absorption	Resident	High
		Leaching to groundwater	Local population
		Flora and fauna	Low
		Construction Worker	Low
	Groundwater	Low	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low
		Resident	Low
		Trespasser	Low
		Flora and fauna	Low
	Direct contact	Buildings and services	Low
		Surface water	Low
	Percolation to groundwater	Local population	Low
		Flora and fauna	Low
	Groundwater	Low	
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low
		Local population	Low
		Flora and fauna	Low
	Direct contact	Buildings and services	Low
		Groundwater	Low
	Indirect contact ingestion or absorption	Local population	Low
		Flora and fauna	Low
Airborne linkage	Inhalation of particulates	Construction Worker	Very high
		Resident	Very High
		Trespasser	Very high
		Flora and fauna	Low
		Local population	Low
	Inhalation of volatile compounds	Construction Worker	Low
		Resident	Low
		Trespasser	Low
		Flora and fauna	Low
		Local population	Low
Vapour intrusion into indoor spaces	Resident	Low	
	Local population	Low	

4.4.3 Historical landfilling to the north east and east (north site)

Linkage type	Pathway	Receptor	Risk
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Medium
		Resident	Medium
		Trespasser	Medium
		Flora and fauna	Low
		Direct contact	Surface water
	Indirect contact ingestion or absorption	Resident	Low
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low
		Resident	Low
		Flora and fauna	Low
		Direct contact	Buildings and services
	Indirect contact ingestion or absorption	Resident	Low
		Leaching to groundwater	Local population
		Flora and fauna	Low
		Construction Worker	Low
	Groundwater	Low	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low
		Resident	Low
		Trespasser	Low
		Flora and fauna	Low
	Direct contact	Buildings and services	Low
		Surface water	Low
	Percolation to groundwater	Local population	Low
		Flora and fauna	Low
		Groundwater	Low
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low
		Local population	Low
		Flora and fauna	Low
	Direct contact	Buildings and services	Low
		Groundwater	Low
	Indirect contact ingestion or absorption	Local population	Low
		Flora and fauna	Low
Airborne linkage	Inhalation of particulates	Construction Worker	Medium
		Resident	Medium
		Trespasser	Medium
		Flora and fauna	Low
		Local population	Low
	Inhalation of volatile compounds	Construction Worker	Low
		Resident	Low
		Trespasser	Low
		Flora and fauna	Low
		Local population	Low
Vapour intrusion into indoor spaces	Resident	Low	
	Local population	Low	

4.4.4 Unidentified 45 gallon drums to the north east (north site)

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	High	
		Resident	High	
		Trespasser	High	
	Direct contact	Flora and fauna	High	
		Surface water	High	
		Indirect contact ingestion or absorption	Resident	Medium
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Medium	
		Resident	Medium	
		Flora and fauna	Medium	
	Direct contact	Buildings and services	Medium	
	Indirect contact ingestion or absorption	Resident	Medium	
	Leaching to groundwater	Local population	Low	
		Flora and fauna	Low	
		Construction Worker	Low	
	Surface water linkage	Direct contact ingestion or absorption	Groundwater	Medium
Construction Worker			Low	
Resident			Low	
Direct contact		Trespasser	Low	
		Flora and fauna	Low	
		Buildings and services	Low	
Percolation to groundwater		Surface water	Low	
		Local population	Low	
		Flora and fauna	Low	
Groundwater linkage	Direct contact ingestion or absorption	Groundwater	Low	
		Construction Worker	Low	
		Local population	Low	
	Direct contact	Flora and fauna	Low	
		Buildings and services	Low	
		Groundwater	Low	
	Indirect contact ingestion or absorption	Local population	Low	
		Flora and fauna	Low	
		Construction Worker	Low	
Airborne linkage	Inhalation of particulates	Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
		Construction Worker	Medium	
	Inhalation of volatile compounds	Resident	Low	
		Trespasser	Medium	
		Flora and fauna	Low	
		Local population	Low	
		Vapour intrusion into indoor spaces	Resident	Low
			Local population	Low

4.4.5 Japanese Knotweed to the south east of the site (north site)

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Surface water	Low	
Subsurface soil linkage	Indirect contact ingestion or absorption	Resident	Low	
	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Flora and fauna	Low	
	Direct contact	Buildings and services	Low	
	Indirect contact ingestion or absorption	Resident	Low	
	Leaching to groundwater	Local population	Low	
		Flora and fauna	Low	
		Construction Worker	Low	
		Groundwater	Low	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Buildings and services	Low	
		Surface water	Low	
	Percolation to groundwater	Local population	Low	
		Flora and fauna	Low	
		Groundwater	Low	
	Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low
Local population			Low	
Flora and fauna			Low	
Buildings and services			Low	
Groundwater			Low	
Indirect contact ingestion or absorption		Local population	Low	
		Flora and fauna	Low	
Airborne linkage		Inhalation of particulates	Construction Worker	Low
			Resident	Low
			Trespasser	Low
	Flora and fauna		Low	
	Local population		Low	
	Inhalation of volatile compounds	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
Vapour intrusion into indoor spaces		Resident	Low	
		Local population	Low	

4.4.6 Made Ground from various industrial land uses (south site)

Linkage type	Pathway	Receptor	Risk		
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	High		
		Resident	High		
		Trespasser	High		
		Flora and fauna	Low		
		Direct contact	Surface water	Low	
	Indirect contact ingestion or absorption	Resident	Low		
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Medium		
		Resident	Medium		
		Flora and fauna	Low		
		Direct contact	Buildings and services	Low	
	Indirect contact ingestion or absorption	Resident	Low		
		Leaching to groundwater	Local population	Low	
	Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low	
			Resident	Low	
Trespasser			Low		
Flora and fauna			Low		
Direct contact			Buildings and services	Low	
Percolation to groundwater			Local population	Low	
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low		
		Local population	Low		
		Flora and fauna	Low		
		Groundwater	Low		
	Direct contact	Buildings and services	Low		
		Groundwater	Low		
	Indirect contact ingestion or absorption	Local population	Low		
		Flora and fauna	Low		
		Airborne linkage	Inhalation of particulates	Construction Worker	Medium
		Airborne linkage	Inhalation of particulates	Resident	Medium
Trespasser	Medium				
Flora and fauna	Low				
Local population	Low				
Construction Worker	Medium				
Inhalation of volatile compounds	Resident		Medium		
	Trespasser		Low		
	Flora and fauna		Low		
	Local population		Low		
	Vapour intrusion into indoor spaces		Resident	Low	
		Local population	Low		

4.4.7 Above ground 9000 and 10000 litre bunded fuel tanks (south site)

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Surface water	Low
	Indirect contact ingestion or absorption	Resident	Low	
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
		Indirect contact ingestion or absorption	Resident	Low
		Leaching to groundwater	Local population	Low
		Flora and fauna	Low	
		Construction Worker	Low	
		Groundwater	Low	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Surface water	Low
		Percolation to groundwater	Local population	Low
		Flora and fauna	Low	
		Groundwater	Low	
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Local population	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Groundwater	Low
		Indirect contact ingestion or absorption	Local population	Low
		Flora and fauna	Low	
Airborne linkage	Inhalation of particulates	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
	Inhalation of volatile compounds	Inhalation of volatile compounds	Construction Worker	Low
			Resident	Low
			Trespasser	Low
			Flora and fauna	Low
			Local population	Low
Vapour intrusion into indoor spaces	Vapour intrusion into indoor spaces	Resident	Low	
		Local population	Low	

4.4.8 Bunded heating oil tank west side to the rear of office building (south site)

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
	Direct contact	Flora and fauna	Low	
		Surface water	Low	
		Resident	Low	
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Flora and fauna	Low	
		Buildings and services	Low	
	Indirect contact ingestion or absorption	Resident	Low	
		Leaching to groundwater	Local population	Low
	Surface water linkage	Direct contact ingestion or absorption	Flora and fauna	Low
			Construction Worker	Low
		Direct contact	Construction Worker	Low
			Resident	Low
Groundwater linkage	Direct contact ingestion or absorption	Trespasser	Low	
		Flora and fauna	Low	
		Buildings and services	Low	
		Groundwater	Low	
	Indirect contact ingestion or absorption	Local population	Low	
		Flora and fauna	Low	
		Groundwater	Low	
		Local population	Low	
Airborne linkage	Inhalation of particulates	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
		Inhalation of volatile compounds	Construction Worker	Low
			Resident	Low
	Trespasser		Low	
	Flora and fauna		Low	
	Local population		Low	
	Vapour intrusion into indoor spaces		Resident	Low
			Local population	Low

4.4.9 Underground fuel storage tanks south of site (south site)

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Surface water	Low
	Indirect contact ingestion or absorption	Resident	Low	
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	High	
		Resident	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
		Indirect contact ingestion or absorption	Resident	Low
		Leaching to groundwater	Local population	Low
		Flora and fauna	Low	
		Construction Worker	High	
		Groundwater	High	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Surface water	Low
		Percolation to groundwater	Local population	Low
		Flora and fauna	Low	
		Groundwater	Low	
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Local population	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Groundwater	High
		Indirect contact ingestion or absorption	Local population	Low
		Flora and fauna	Low	
Airborne linkage	Inhalation of particulates	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
	Inhalation of volatile compounds	Inhalation of volatile compounds	Construction Worker	Medium
			Resident	Low
			Trespasser	Low
			Flora and fauna	Low
			Local population	Low
Vapour intrusion into indoor spaces	Vapour intrusion into indoor spaces	Resident	Low	
		Local population	Low	

4.4.10 Generation of ground gas from Made Ground and/or organic soils

Linkage type	Pathway	Receptor	Risk	
Surface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Surface water	Low
	Indirect contact ingestion or absorption	Resident	Low	
Subsurface soil linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
		Indirect contact ingestion or absorption	Resident	Low
		Leaching to groundwater	Local population	Low
		Flora and fauna	Low	
		Construction Worker	Low	
		Groundwater	Low	
Surface water linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Surface water	Low
		Percolation to groundwater	Local population	Low
		Flora and fauna	Low	
		Groundwater	Low	
Groundwater linkage	Direct contact ingestion or absorption	Construction Worker	Low	
		Local population	Low	
		Flora and fauna	Low	
		Direct contact	Buildings and services	Low
			Groundwater	Low
		Indirect contact ingestion or absorption	Local population	Low
		Flora and fauna	Low	
Airborne linkage	Inhalation of particulates	Construction Worker	Low	
		Resident	Low	
		Trespasser	Low	
		Flora and fauna	Low	
		Local population	Low	
	Inhalation of volatile compounds	Inhalation of volatile compounds	Construction Worker	Low
			Resident	Low
			Trespasser	Low
			Flora and fauna	Low
			Local population	Low
Vapour intrusion into indoor spaces	Vapour intrusion into indoor spaces	Resident	Medium	
		Local population	Low	

4.5 Description of possible pollutant linkages for controlled waters

According to the Regional Hydrogeology Map of Northern East Anglia, the Chalk is the principal aquifer for the area. The estimated minimum hydrostatic level of the Chalk water table in the vicinity of the site is approximately at Ordnance Survey Datum.

The northern Deal Ground site is between approximately 1 and 4 metres above Ordnance Survey Datum. Therefore, the groundwater is thought to be approximately 1 and 4 metres below the site.

The southern May Gurney site is approximately 2 metres above Ordnance Survey Datum. Therefore, the groundwater is thought to be approximately 2 metres below the site.

4.6 Discussion of uncertainties and gaps in information

It may be possible that there are areas of contamination that have not been found during the walkover survey or the studying of historical maps.

5.0 Discussion of risks posed by the site

5.1 Made Ground from historical land use (north site)

The site investigation undertaken in August 2021 by NPL following the removal of the surface hardstanding targeted the northern former industrial area of the Deal Ground (northern site). Thirty nine soil samples were retrieved from across the site and tested for contaminants of concern. The samples were from the Made Ground deposits which were present in 16 of the 19 window sample holes. The average depth of the deposit across the site was 0.50m. In WS04 1.40m of made ground was present. All the samples were within guidance threshold values for residential end use. Positive identification of Chrysotile Asbestos was found in one sample. The report also investigated the potential risk of near surface contaminants migrating to the groundwater. Samples tested revealed that no significant contamination was present.

The risk in this instance from the Made Ground in this area of the site has been assessed as Low Risk – considered conceivable but unlikely.

5.2 ACM in north west corner (north site)

Cement board fragments were present on a polythene sheet and visible in the surface soils in this area of the site.

The risk to some of the receptors via a surface soil linkage and airborne linkage is very high (considered that is expected to happen).

It is recommended that all potential asbestos containing material (ACM) should be removed by a suitably licensed contractor and disposed of to a suitably licensed facility. Consignment notes for any removed asbestos and documentation stating that all asbestos has been disposed of from the site should be submitted to Norwich City Council. Post removal and remediation it is recommended further surface soil samples are retrieved and tested for the presence of Asbestos.

After the removal of all ACM from the site, following the conditions above, the remaining potential risk is very low.

5.3 Historical landfilling in the north east and east (north site)

This area of the site was investigated in 1992 by May Gurney which comprised twenty trial pits one borehole and two monitoring wells. The Made Ground was not proven in 6 of the trial pits at a maximum depth of 2.30 metres. The Made Ground was 4.20 metres and 3.90 metres thick in BH2 and MW5 respectively. An average depth of 1.60 metres was present. Most of the material encountered comprised, brick, concrete, asphalt, sand, wood, glass, chalk, slate, ash. When compared to historical guidance threshold values some elevated metals were present. VOC's were seen as an isolated issue. Most of the conservation area had not been filled.

The risk in this instance from the deposited materials in this area of the site has been assessed as Medium Risk – considered possible but unusual to some of the site receptors. It is thought the majority of these materials would be suitable for screening and recycling subject to further testing.

5.4 Unidentified 45 gallon drums to the north east (north site)

Eleven unidentified 45 gallon drums were present on the site with a number of tyres and engine parts. The drums were thought to be empty although further inspection is required.

These are thought to represent a High Risk (considered probable about 50% chance) to some receptors via a surface soil linkage and a Medium Risk (considered possible but unusual) to some receptors via a subsurface soil linkage. Once removed it is recommended the surface and subsurface soils in this area are appropriately tested for any residual contents and remediated accordingly.

5.5 Japanese Knotweed to the south east of the site (north site)

Japanese Knotweed (*Fallopia Japonica*) has been positively identified in a localised area on the north site. The area is being treated by Eastern Counties Knotweed Ltd. From information supplied by the client herbicidal treatment over the growing season has been ongoing since 2021.

This treatment appears to have brought the knotweed under control and as the eradication is being managed by a specialist contractor the risk of the *Fallopia Japonica* spreading to other areas of the site is considered Low (conceivable but unlikely).

5.6 Made Ground from various industrial land use (south site)

This area of the site was investigated in 1997 by May Gurney where eleven trial pits were excavated mainly in the south eastern portion of the site. Made Ground was present from depths ranging from 0.60m to 1.60m. Peat was present below the Made Ground to a maximum depth of 3.40m. In 2005 a further 13 window sample holes and 2 boreholes were drilled. Six additional investigations have been made on the site including environmental risk assessments, environmental constraints report. Elevated Lead, TPH and PAH was present in some of the Made Ground. Groundwater testing indicated no significant contamination.

The Made Ground on this site, particularly on the eastern side (the western half concrete and asphalt covered) represents a High Risk (considered probable about 50% chance) to some receptors via a surface soil linkage and a Medium Risk (considered possible but unusual).

5.7 Above ground 9000 and 10000 litre bunded fuel tanks (south site)

Two large diesel tanks are present close to the northern site boundary on the west side of the site (photographs 27 and 28). Both tanks appeared in good condition and are located within brick bunds with intact bases. No evidence of staining was seen around the tanks.

The risk in this instance from these tanks has been assessed as Low – considered conceivable but unlikely.

5.8 Bunded heating oil tank west side to the rear of office building (south site)

An empty heating oil tank was present to the rear of the office building located in a brick bund (photograph 21). No leaks were evident from the bund as it was retaining rain water.

The risk in this instance the from the tank has been assessed as Low – considered conceivable but unlikely.

5.9 Underground fuel storage tanks south of site (south site)

The historical investigations on the site have revealed the presence of two below ground fuel tanks (south west of the site). These have been decommissioned by filling with RG22 foam in 1996. It was not known if the tanks had been removed from the site. In 2008 further investigation was recommended by the EA regarding the presence of chlorinated solvents notably Trichloroethane. No TCE was detected in significant quantities in any of the samples however some BTEX and hydrocarbons were detected. May Gurney commissioned further works to identify the impact of the known contamination on the deeper groundwater. BTEX was encountered although the distribution was variable. The main source was considered to be the in the vicinity of the underground fuel tanks (WS08 and BH103).

A High Risk (considered about 50% chance) is deemed appropriate to the groundwater in the vicinity of these tanks. It has to be considered that the tanks have been decommissioned therefore the potential source removed and also the amount of time since the previous investigation which would suggest dilution and dispersal through natural attenuation of any potential remaining hydrocarbons.

It is recommended further intrusive work is carried out in the location of the tanks to assess the current impact on the groundwater and surrounding soils. Appropriate remediation would be to locate the tanks, remove and then validate the areas.

5.10 Generation of ground gas from Made Ground and/or organic soils

A recent gas investigation was included in the NPL report on the north site in 2021. A maximum reading of 4.1% Carbon Dioxide was recorded in WS04 on 07/07/21. Generally, across the site the CO₂ results were well below 1%. No methane was recorded and no driving mechanisms relevant to the gas screening value. Following the CIRIA report C665 the site was classified as traffic light situation GREEN indicative of a negligible gas regime where protection measures were not considered necessary. Further assessment of the north site is not considered necessary.

A gas investigation in the north east portion of the south site in 2009 revealed 4.6% Methane and 4.4% Carbon Dioxide providing an initial indication of Amber 1 gas regime although it is not clear if flow was recorded. The design masterplan shows this area as undeveloped green space. Given the presence of more extensive deposits of Peat on the eastern half of the site and the lack of data on the western side the risk has been assessed as Medium (considered possible but unusual). It is recommended further gas monitoring is undertaken including VOC's and SVOC's.

6.0 Recommendations

Based upon the information contained herein it is recommended that a targeted site investigation and quantitative risk assessment is carried out on the north and south site.

Deal Ground North Site

A remediation method statement for the removal of the ACM fragments on the polythene and in the surface Made Ground needs to be implemented for the north east corner of the site. Further sampling post remediation will determine if the area is free of Asbestos contamination.

Soil sampling and appropriate testing to be undertaken in the area of the unidentified 45 gallon drums. Depending on the findings, subsequent remediation may be required.

Trial pitting is recommended in the area of the historic landfill primarily to determine if the materials present are suitable for recycling and the relevant percentages of each constituent or need to be disposed of under the correct waste category. The samples will require geotechnical analysis and screening for contaminants.

Further ground gas monitoring visits of existing monitoring locations

May Gurney South Site

A ground penetrating radar survey determine if the two decommissioned tanks area still present in the site. Once located a targeted further site investigation around the decommissioned underground fuel storage tanks to determine if residual hydrocarbon contamination is present in the soils and groundwater.

Targeted ground gas investigation in the proposed development areas to include testing for VOC's and SVOC's to ensure the implementation of the appropriate gas protection measures required.

Results will be assessed against SGV's, Atkins ATRISK threshold values for residential with home grown produce land use with 1% soil organic matter and LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment.

Norfolk Partnership Laboratory
Site Investigation Section

This report was prepared under the direction of

Head of Laboratory Services



I D Brown

Author of report

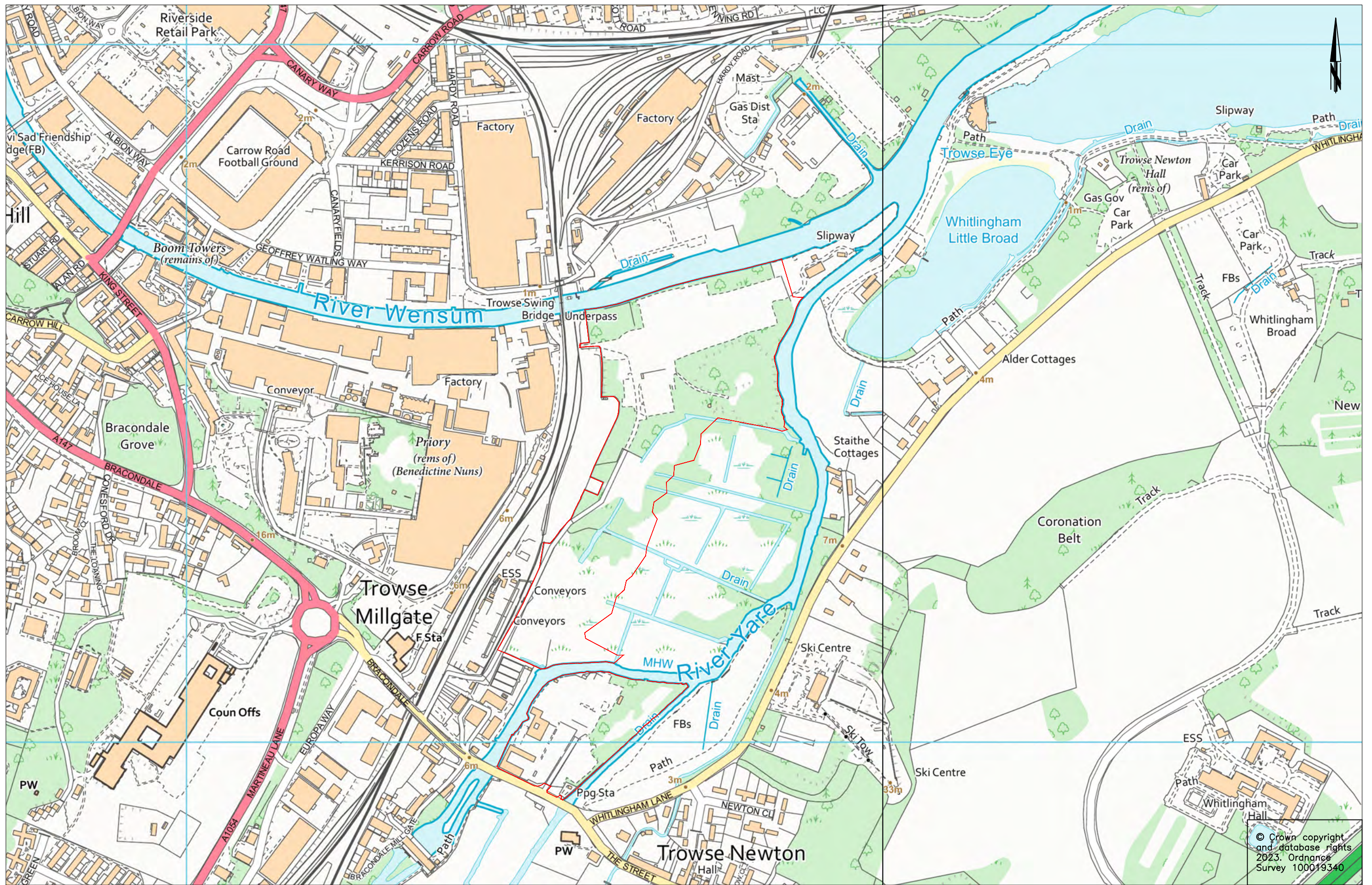
Geoenvironmental Engineer



S P Berwick

Date:28/04/2023

Appendix A



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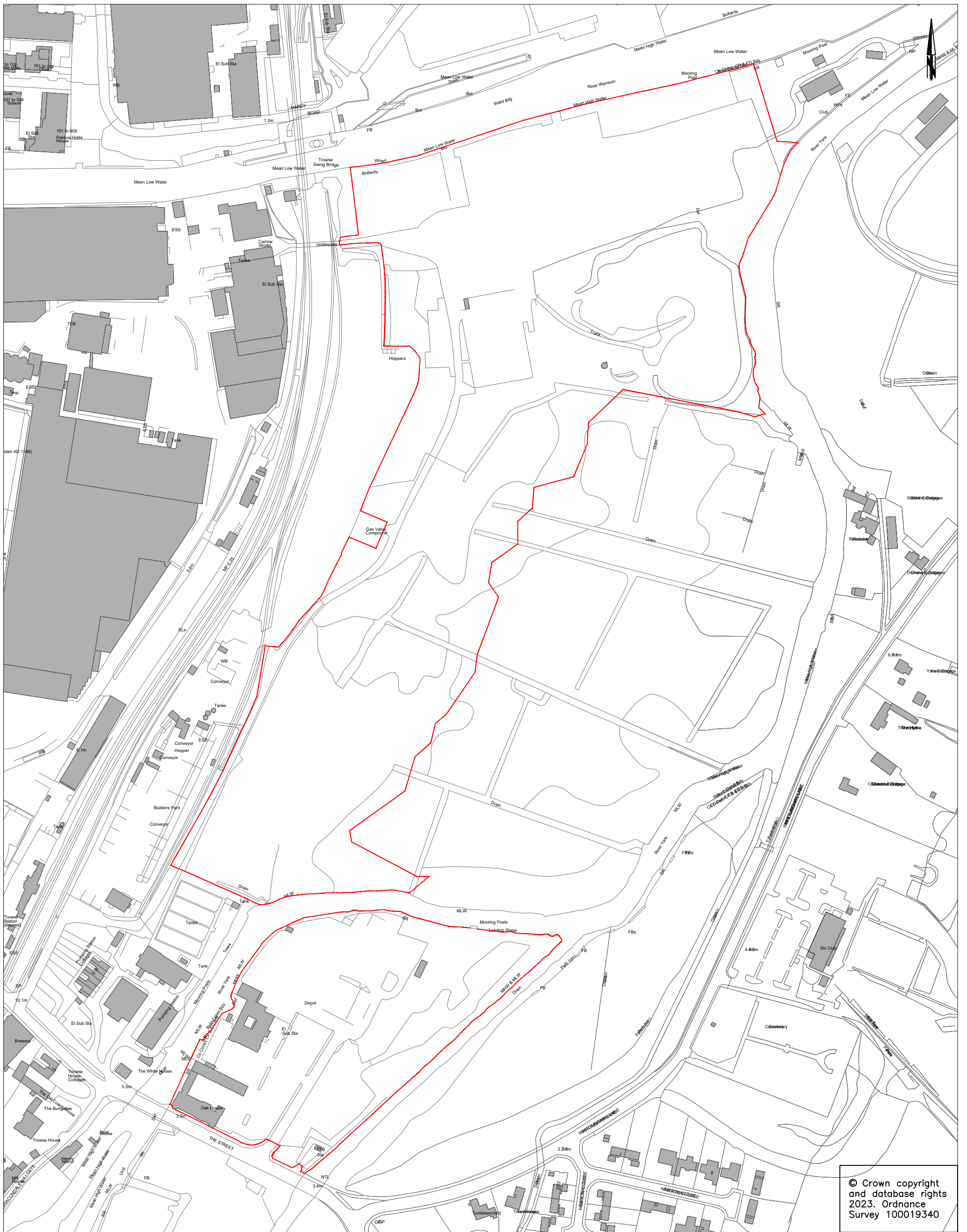


Tom McCabe
 Executive Director of
 Community and Environmental Services
 Norfolk County Council
 County Hall, Martineau Lane
 Norwich NR1 2SG

DRAWING TITLE
 Deal Ground, Norwich
 Desk Study
 Site Location Plan

REV.	DESCRIPTION	DRAWN BY	CHECKED	DATE

SURVEYED BY	INITIALS	DATE	DRAWING No.
OS	OS	03/23	001
DESIGNED BY	JP	04/23	PROJECT TITLE
DRAWN BY	JP	04/23	Deal Ground, Norwich Desk Study
CHECKED BY	IDB	04/23	SCALE
			1: 5000 @A3
			FILE No.
			-



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DRAWING TITLE
 104182 Deal Ground, Norwich
 Desk Study
 Site Location Plan

Tom McCabe
 Executive Director of
 Community and Environmental Services
 Norfolk County Council
 County Hall
 Martineau Lane
 Norwich NR1 2SG



REV.	DESCRIPTION	DRAWN	CHECKED	DATE

SURVEYED BY	INITIAL	DATE	DRAWING No.
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DESIGNED BY	JP	04/23	PROJECT TITLE
DRAWN BY	JP	04/23	Deal Ground, Norwich
CHECKED BY	IDB	04/23	Desk Study
SCALE			FILE No.
1: 2500 @ A3			104182









Appendix B

Geology 1:50,000 Maps Legends



Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WGR	Worked Ground (Undivided)	Void	Not Supplied - Holocene
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	LOFT	Lowestoft Formation	Diamicton	Not Supplied - Anglian
	HPLO	Happisburgh Glacigenic Formation And Lowestoft Formation (Undifferentiated)	Sand and Gravel	Not Supplied - Anglian
	LOFT	Lowestoft Formation	Sand and Gravel	Not Supplied - Anglian
	LEHI	Leet Hill Sand And Gravel Member	Sand and Gravel	Not Supplied - Pleistocene
	HPGL	Happisburgh Glacigenic Formation	Diamicton	Not Supplied - Pleistocene
	SMCL	Sheringham Cliffs Formation	Sand and Gravel	Not Supplied - Pleistocene
	RTD1	River Terrace Deposits, 1	Sand and Gravel	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	CRAG	Crag Group	Sand and Gravel	Not Supplied - Pliocene
	LPCK	Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation and Portsdown Chalk Formation (Undifferentiated)	Chalk	Not Supplied - Turonian

Geology 1:50,000 Maps

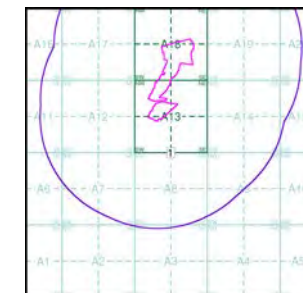
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.

The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	1
Map Sheet No:	161
Map Name:	Norwich
Map Date:	1975
Bedrock Geology:	Available
Superficial Geology:	Available
Artificial Geology:	Available
Faults:	Not Supplied
Landslip:	Not Available
Rock Segments:	Not Supplied

Geology 1:50,000 Maps - Slice A

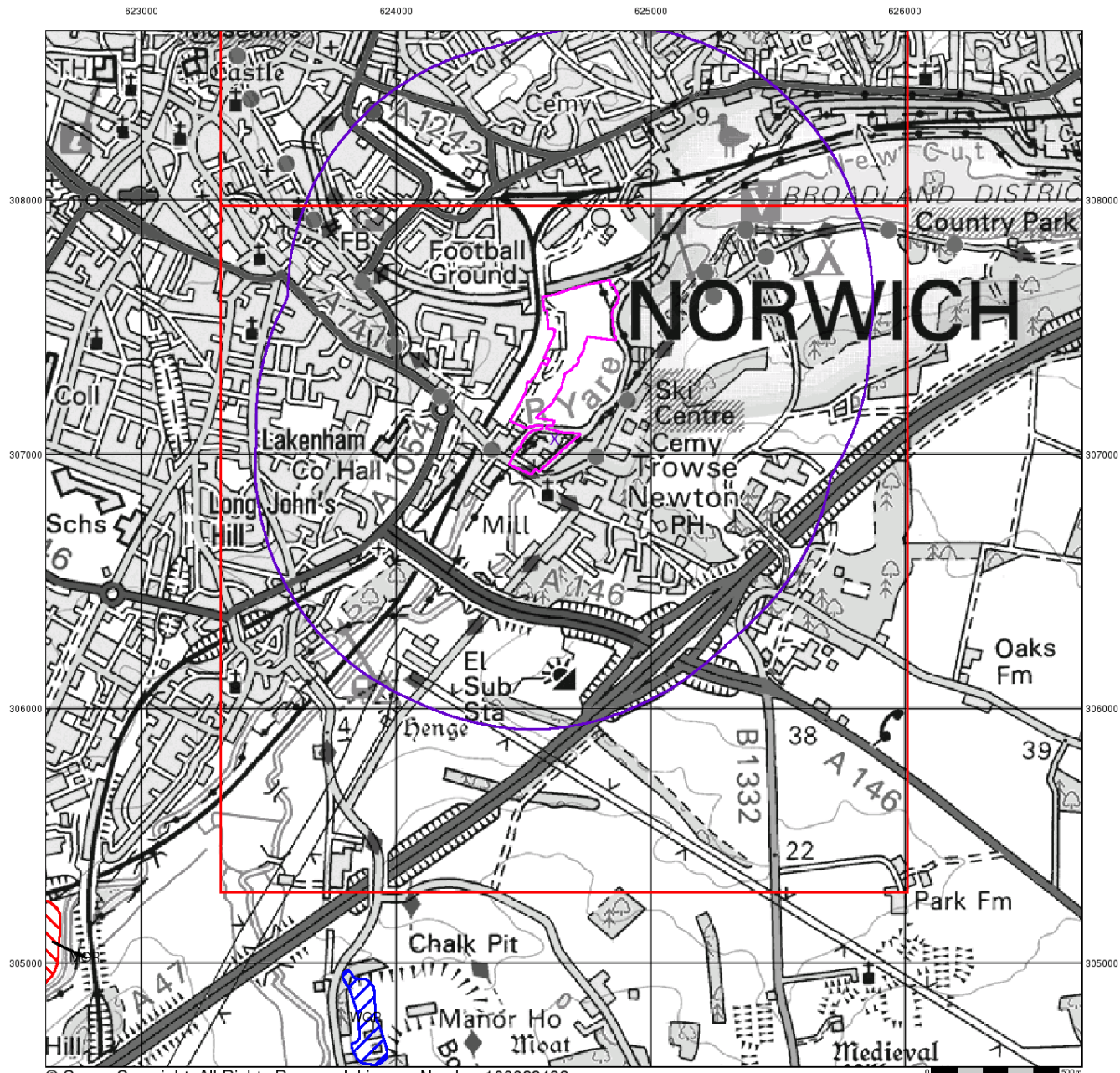


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Search Buffer (m):	1000

Site Details:

Site at, Trowse Newton, Norfolk



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Artificial Ground and Landslip

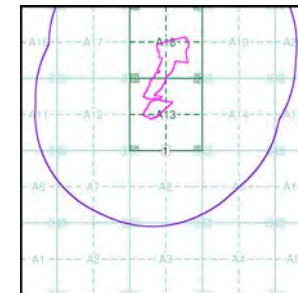
Artificial ground is a term used by BGS for those areas where the ground surface has been significantly modified by human activity. Information about previously developed ground is especially important, as it is often associated with potentially contaminated material, unpredictable engineering conditions and unstable ground.

Artificial ground includes:

- Made ground - man-made deposits such as embankments and spoil heaps on the natural ground surface.
- Worked ground - areas where the ground has been cut away such as quarries and road cuttings.
- Infilled ground - areas where the ground has been cut away then wholly or partially backfilled.
- Landscaped ground - areas where the surface has been reshaped.
- Disturbed ground - areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

Mass movement (landslip) deposits on BGS geological maps are primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground. The dataset also includes foundered strata, where the ground has collapsed due to subsidence.

Artificial Ground and Landslip Map - Slice A

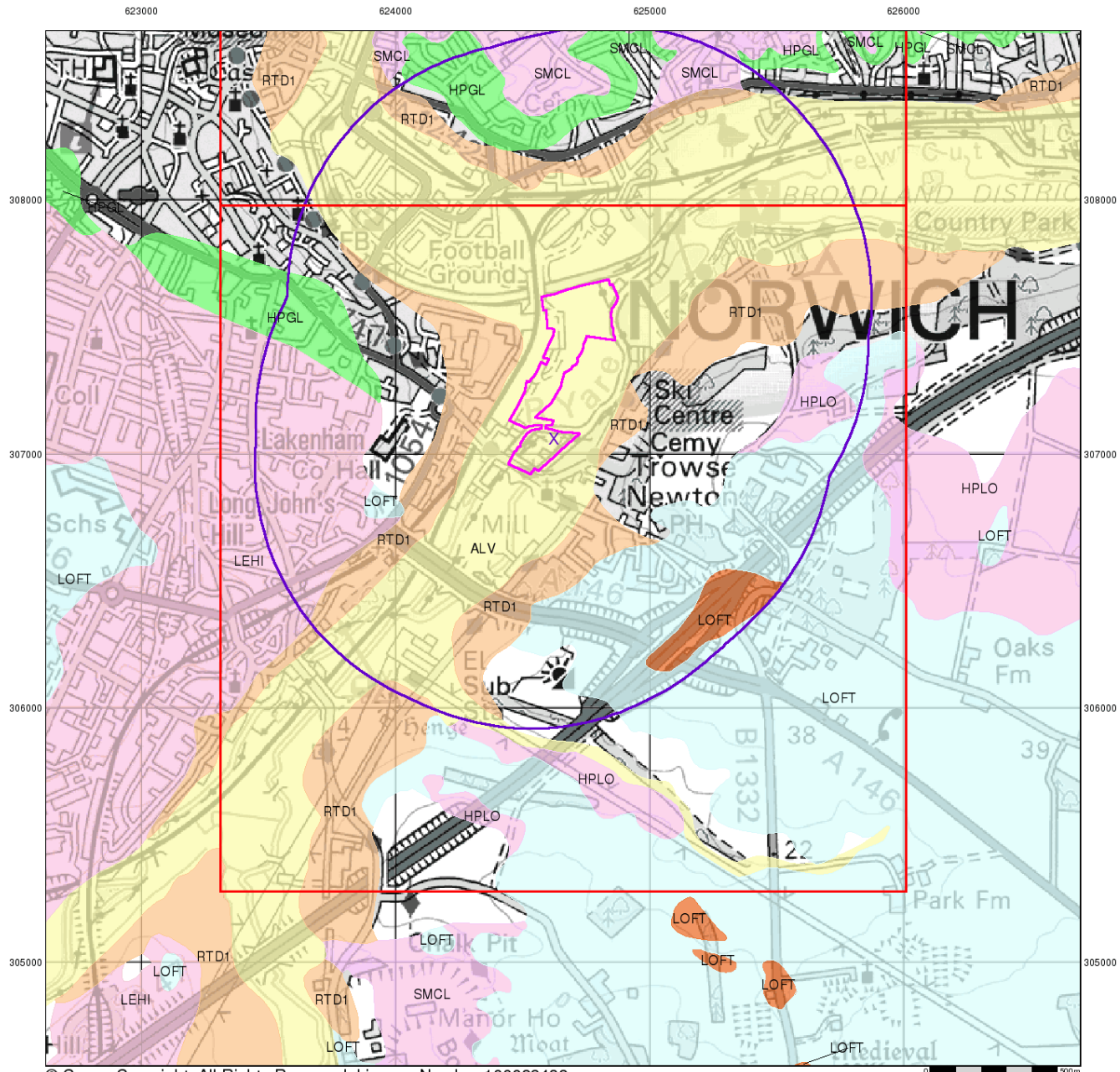


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Site Details:

Site at, Trowse Newton, Norfolk



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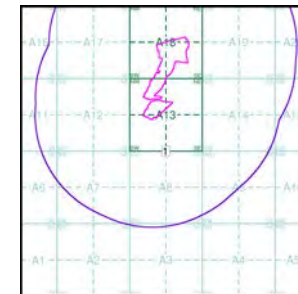
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



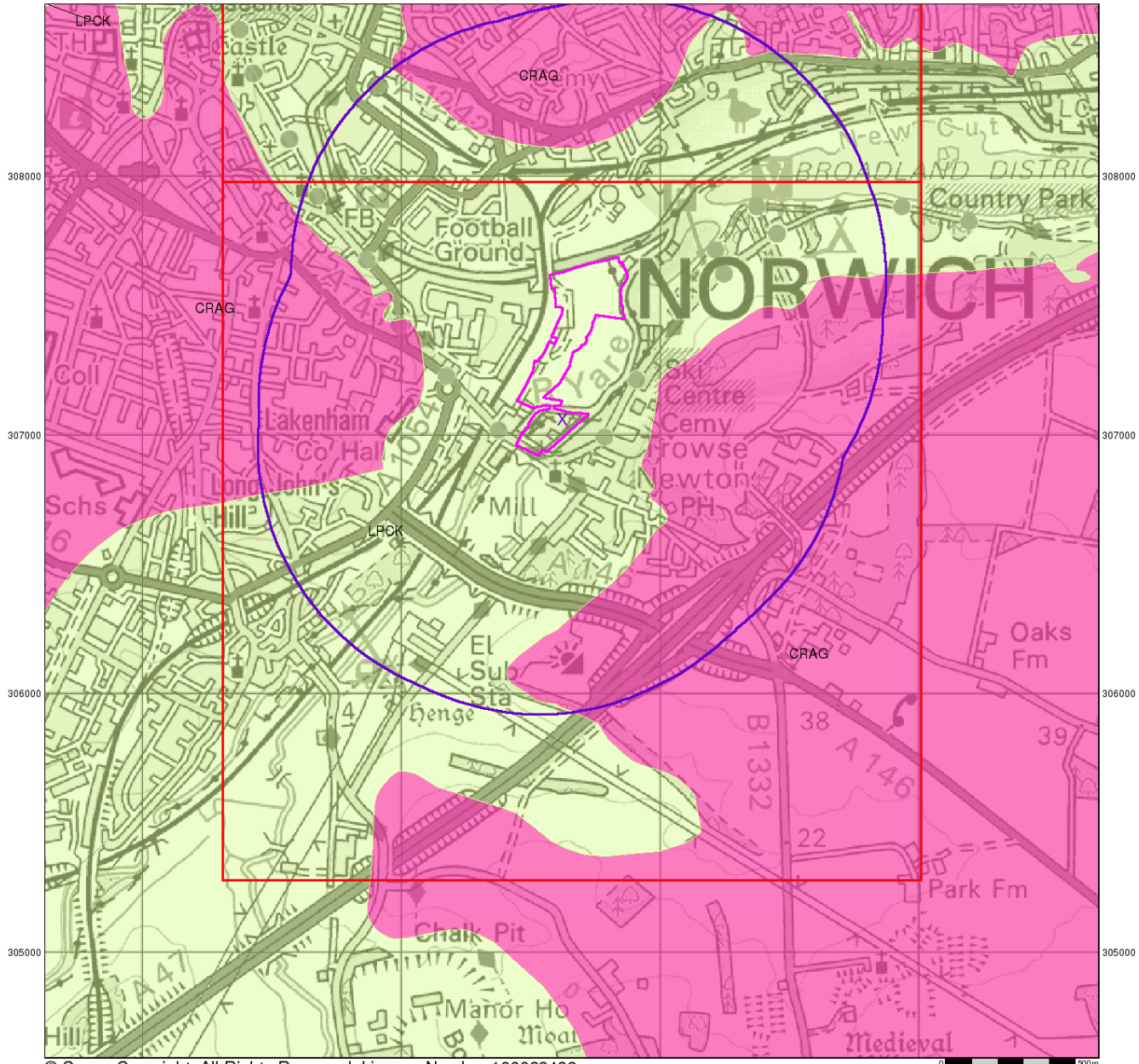
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Site Details:

Site at, Trowse Newton, Norfolk

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Bedrock and Faults

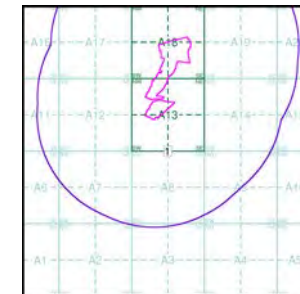
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A



Order Details:

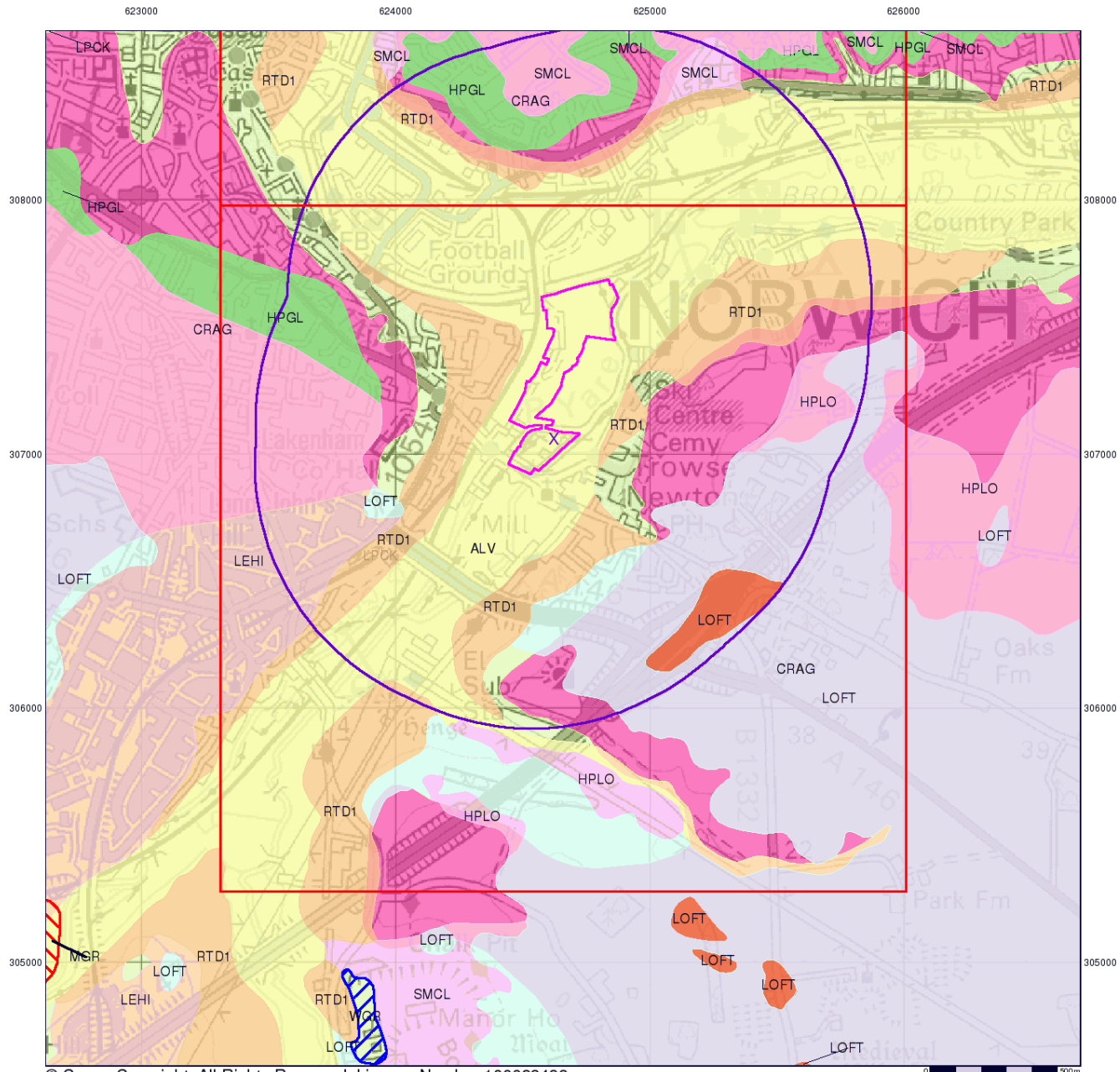
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Site Details:

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Combined Surface Geology

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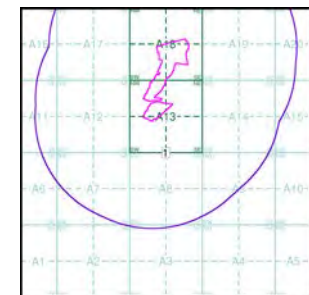
Additional Information

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Contact

British Geological Survey
 Kingsley Dunham Centre
 Keyworth
 Nottingham
 NG12 5GG
 Telephone: 0115 936 3143
 Fax: 0115 936 3276
 email: enquiries@bgs.ac.uk
 website: www.bgs.ac.uk

Combined Geology Map - Slice A



Order Details:

Order Number: 309725319_1_1
 Customer Reference: 104182
 National Grid Reference: 624620, 307060
 Slice: A
 Site Area (Ha): 12.41
 Search Buffer (m): 1000

Site Details:


Site at, Trowse Newton, Norfolk

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Geology 1:50,000 Maps Legends



Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
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Geology 1:50,000 Maps

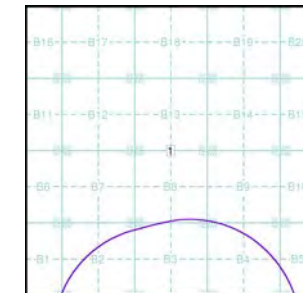
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Map Name:	Norwich
Map Date:	1975
Bedrock Geology:	Available
Superficial Geology:	Available
Artificial Geology:	Available
Faults:	Not Supplied
Landslip:	Not Available
Rock Segments:	Not Supplied

Geology 1:50,000 Maps - Slice B



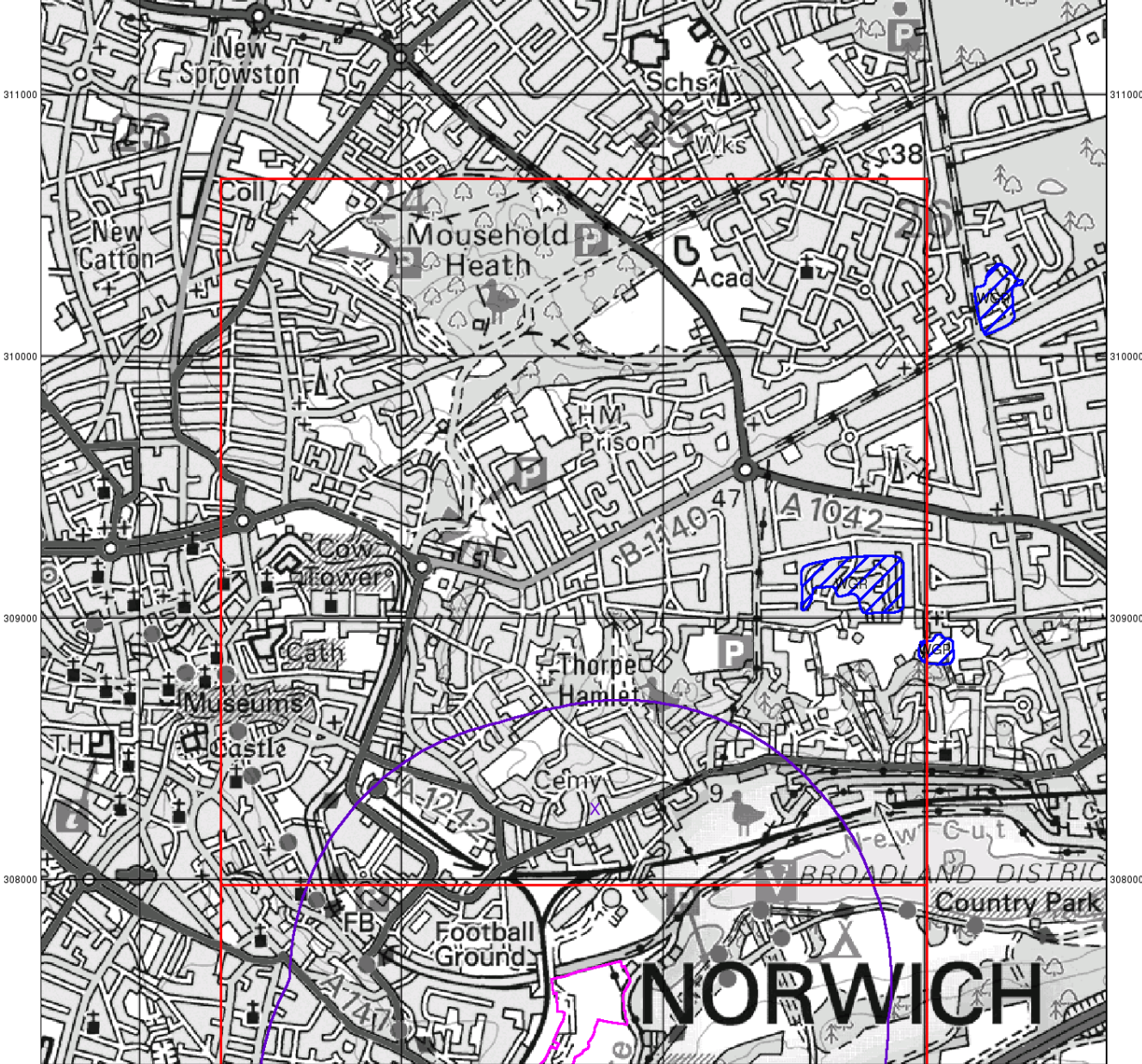
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Artificial Ground and Landslip

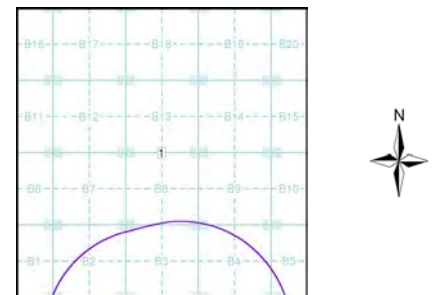
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Artificial Ground and Landslip Map - Slice B



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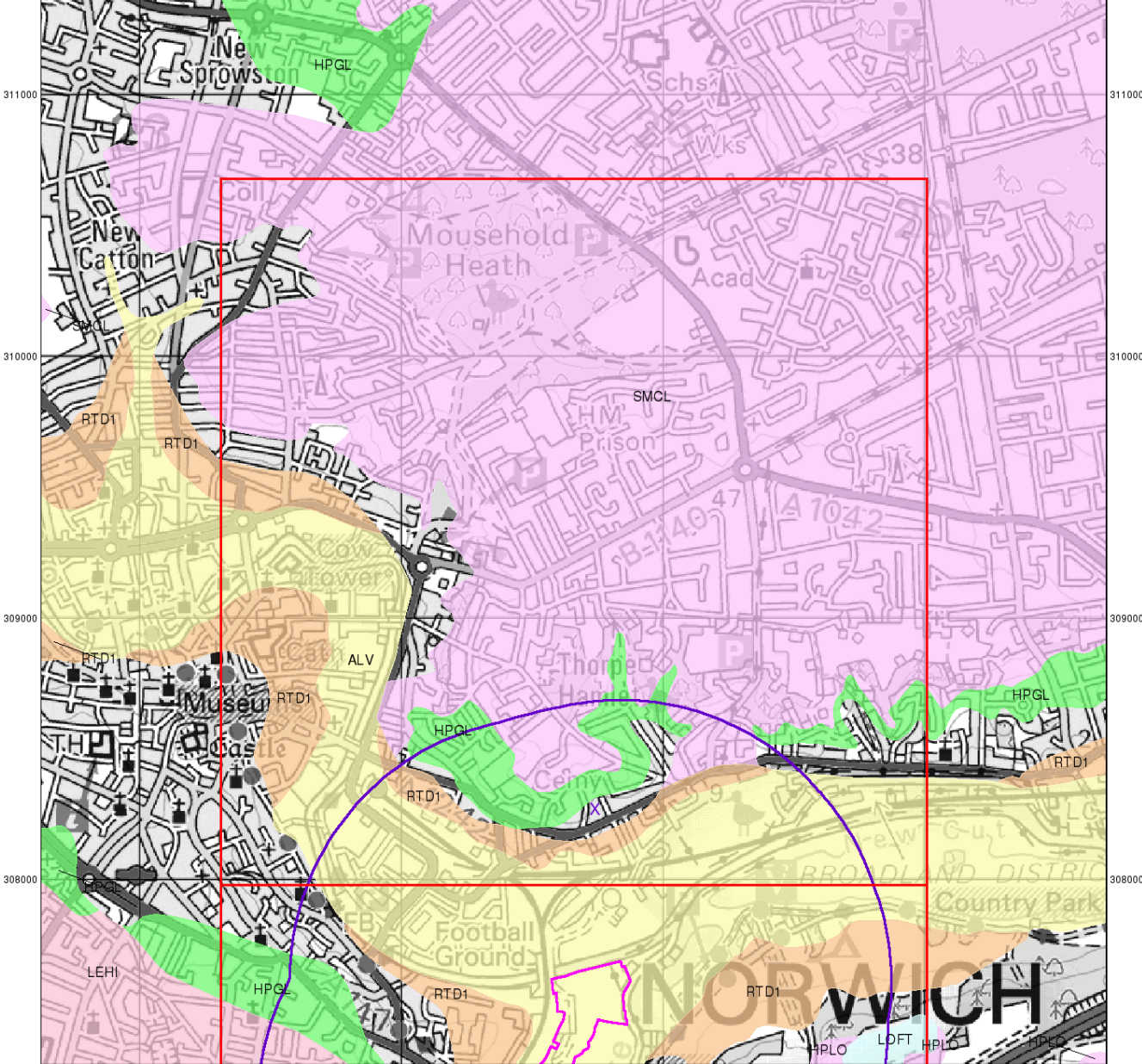
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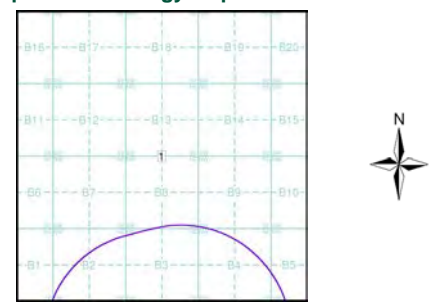
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Superficial Geology Map - Slice B



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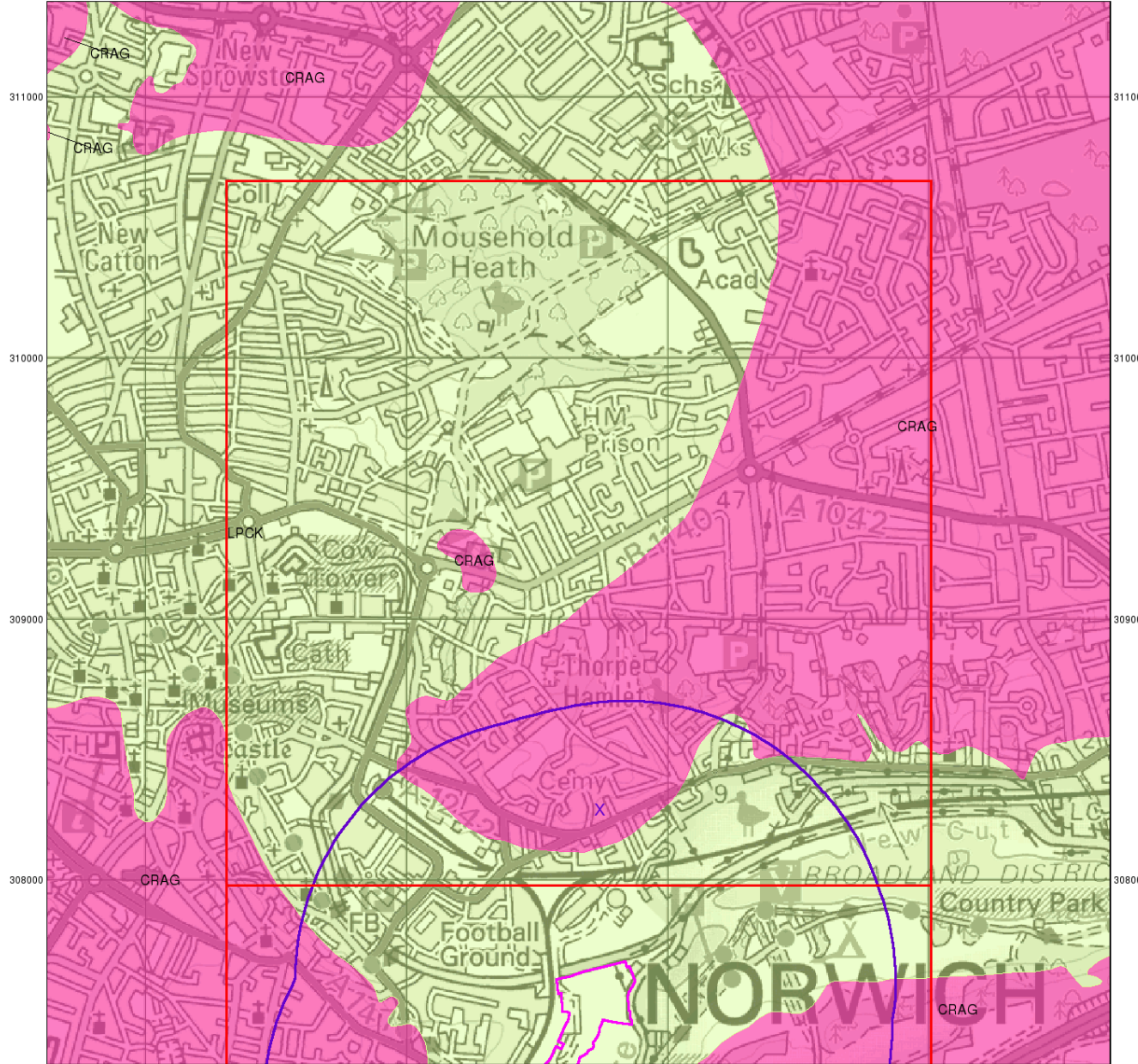
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Bedrock and Faults

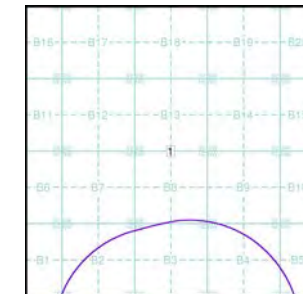
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Bedrock and Faults Map - Slice B



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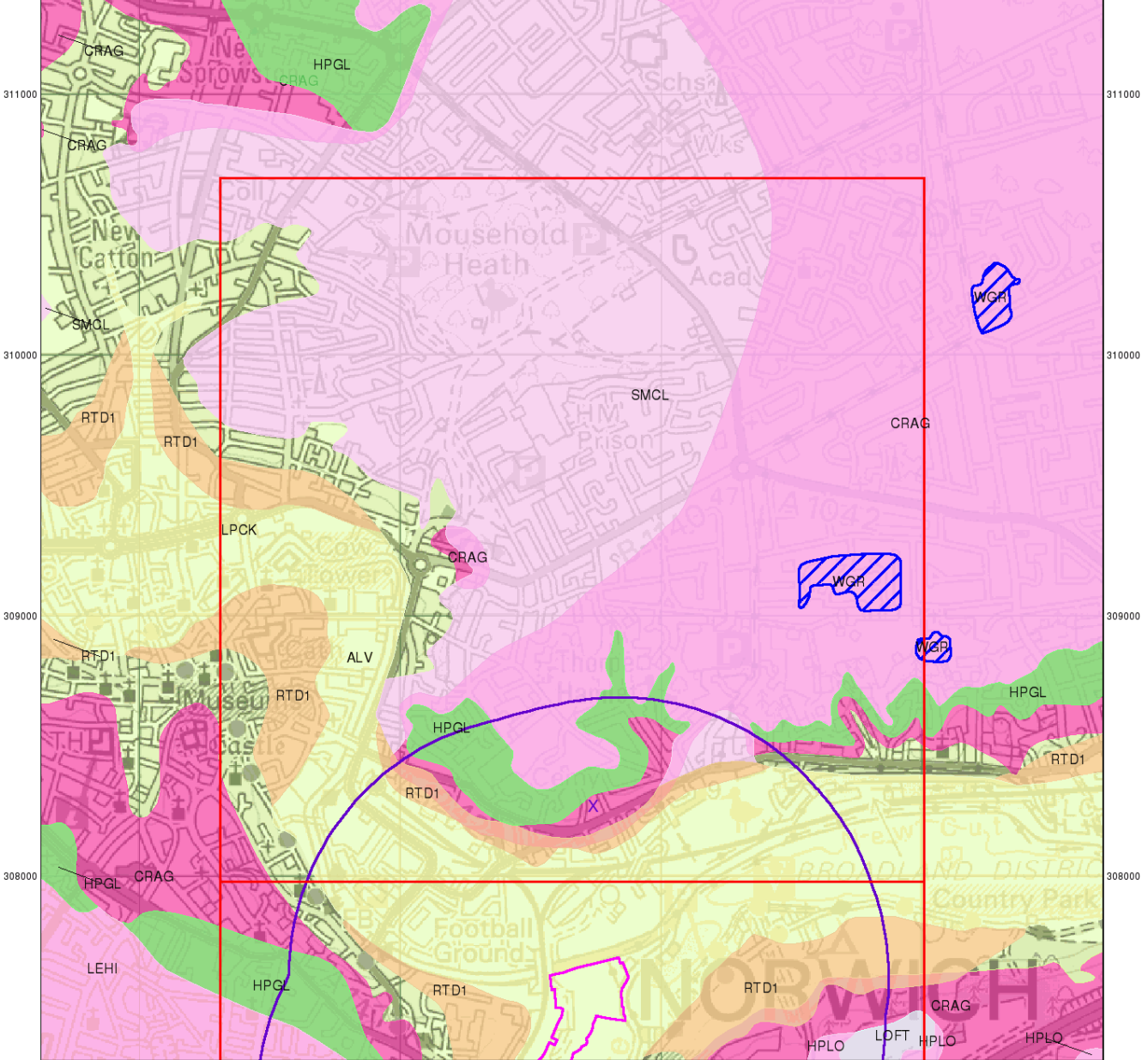
Site Details:

Site at, Trowse Newton, Norfolk

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Combined Surface Geology

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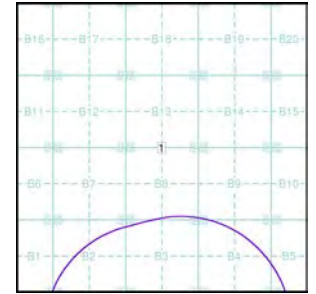
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Contact

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 website: www.bgs.ac.uk

Combined Geology Map - Slice B



Order Details:

Order Number: 309725319_1_1
 Customer Reference: 104182
 National Grid Reference: 624740, 308270
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 Site Area (Ha): 12.41
 Search Buffer (m): 1000

Site Details:

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Appendix C



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Tom McCabe
 Executive Director of
 Community and Environmental Services
 Norfolk County Council
 County Hall, Martineau Lane
 Norwich NR1 2SG

DRAWING TITLE
 Deal Ground, Norwich
 Desk Study
 1914 OS Map

REV.	DESCRIPTION	DRAWN BY	CHECKED	DATE

SURVEYED BY	INITIALS	DATE	DRAWING No.
OS	OS	03/23	006
DESIGNED BY	JP	04/23	PROJECT TITLE
DRAWN BY	JP	04/23	Deal Ground, Norwich Desk Study
CHECKED BY	IDB	04/23	SCALE
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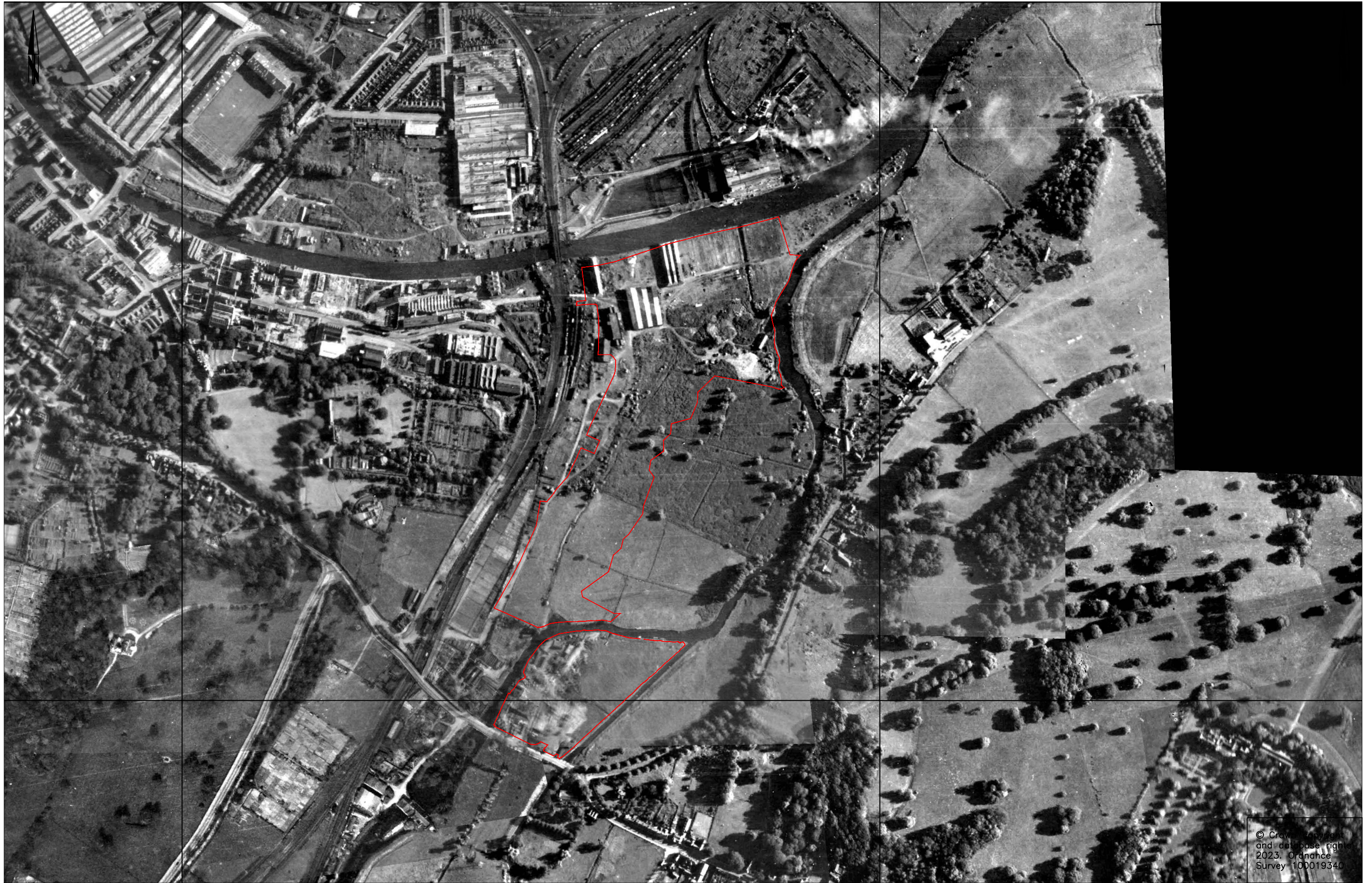


Tom McCabe
Executive Director of
Community and Environmental Services
Norfolk County Council
County Hall, Martineau Lane
Norwich NR1 2SG

DRAWING TITLE
Deal Ground, Norwich
Desk Study
1928 OS Map

REV.	DESCRIPTION	DRAWN BY	CHECKED	DATE

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	JP	04/23	
DRAWN BY	JP	04/23	SCALE
CHECKED BY	IDB	04/23	1: 5000 @A3
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REV.	DESCRIPTION	DRAWN BY	CHECKED	DATE

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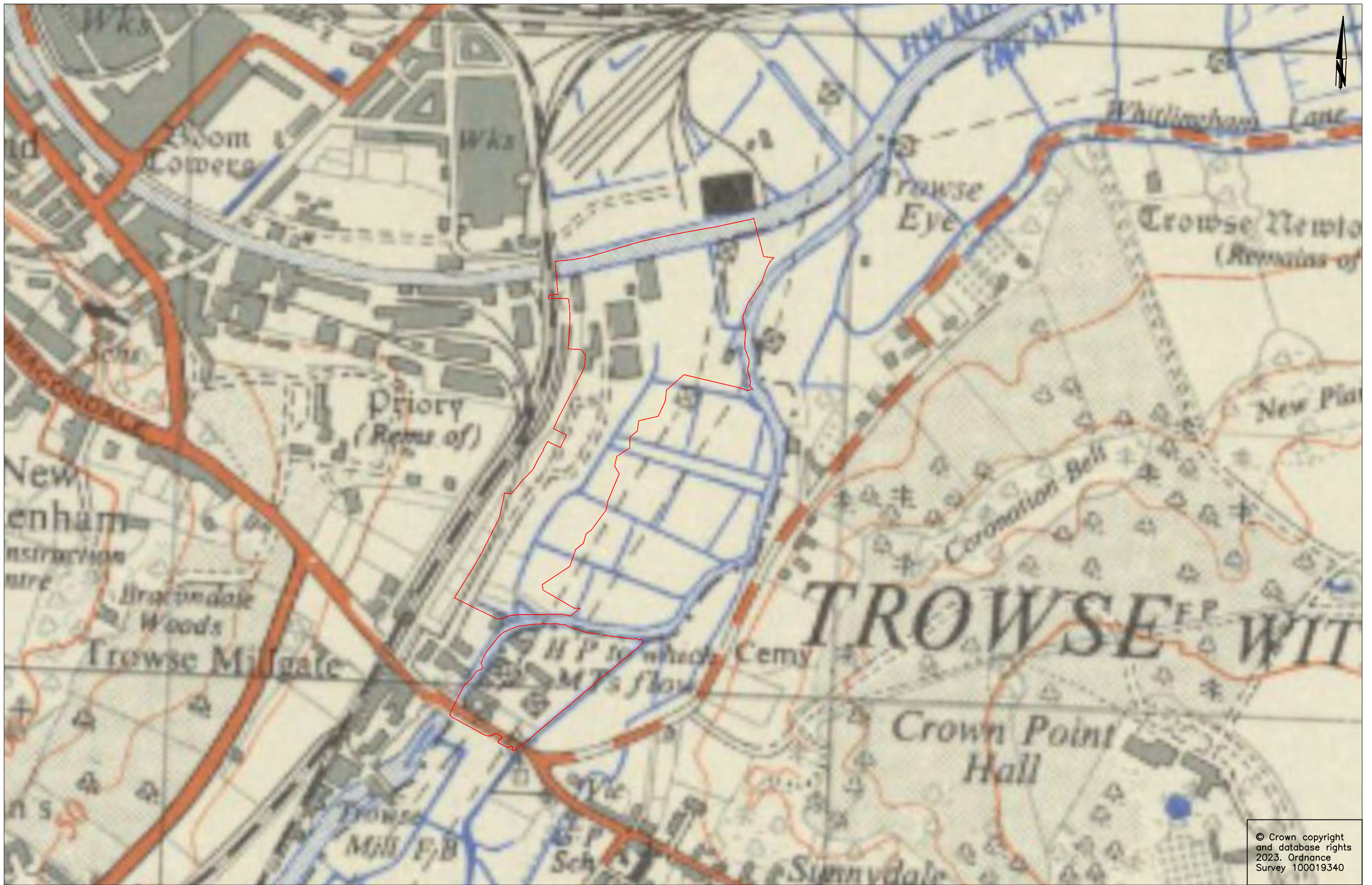


Tom McCabe
Executive Director of
Community and Environmental Services
Norfolk County Council
County Hall, Martineau Lane
Norwich NR1 2SG

DRAWING TITLE
Deal Ground, Norwich
Desk Study
1947 OS Map

REV.	DESCRIPTION	DRAWN BY	CHECKED	DATE

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DRAWN BY	JP	04/23	Deal Ground, Norwich
CHECKED BY	IDB	04/23	Desk Study
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SURVEYED BY	OS	03/23	008
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