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Preliminary Risk Assessment

Stairfoot Glassworks, Wombwell Lane,
Barnsley

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1. ADDRESS AND SITE DETAILS

Address:	Stairfoot Glassworks, Wombwell Lane, Barnsley		
NGR:	437880, 405014	Area:	6.39 hectares (ha)
Site use:	Currently disused land		
Setting:	Located on Wombwell Lane, approximately 3.4km south-east from Barnsley Town Centre.		

2. ASSESSMENT PURPOSE AND OBJECTIVES

This Preliminary Risk Assessment was prepared by Ramboll UK Limited ("Ramboll") on behalf of Potters Ballotini Limited (the "client"). The assessment was commissioned in connection with the client's proposed redevelopment of the site. It is understood that the site is proposed to be redeveloped as a glass and metal recycling facility with associated buildings and outside yard areas. The redevelopment will include the construction of a clad building for internal processing works (from herein "main works"), construction of a workshop and admin office, construction of a gatehouse, external cullet bays, external processing area, lorry park, storage areas, car park and access.

The main objective of this assessment was to assess the potential for significant soil or groundwater contamination, both at and in the immediate vicinity of the site, and its likely implications to the client's proposed redevelopment. A secondary objective was to establish the current regulatory flood zone classification for the site.

No sampling or analysis of soils, waters or other materials was undertaken as part of the preliminary risk assessment. Review of compliance with environmental legislation is outside the scope of this assessment.

3. ASSESSMENT BASIS

☒	Site Visit	☐	Environment Agency (EA)
☒	Map History	☒	Petroleum Authority Enquiry
☒	Environmental Database Review	☒	Review of Previous Reports
☒	Planning Records Review	☒	Geological and Hydrogeological Review
☒	Environmental Health Department Enquiry	☒	Mining Records Search
☒	Flood zone designation review	☒	Unexploded Ordnance Screening

4. SITE VISIT

The following information was derived from a site visit undertaken on 7 September 2023 by Michael Hazlehurst of Ramboll. Discussions were held with Adrian Anstess, (Snr European Project Engineer of Potters Ballotini Limited), who has worked for the company for over 37 years (the 'facility representative'). The purpose of the site visit was to assess whether there is potential for significant ground contamination arising from current site activities.

Areas of the site that could not be accessed include areas in the south-eastern corner where there was extensive vegetation.

Site Layout and Activities

The site is accessed via Wombwell Road on the western site boundary.

The central area of the site (approximately 35% of the total site area) comprises concrete and asphalt hardstanding with surface features of the former Stairwell Brickworks buildings. To the north of the site is an area of rough ground which is approximately one to three metres higher than the central hardstanding area. In the north-west of the site, beyond a metal fence are stockpiles of building waste (brick and concrete) and clay soil. The area to the south-east is approximately one to two metres higher than the central area of the site and comprises a wooded area and overgrown land that was reported to be landfilled.

In the centre of the site between the hardstanding area and the raised land is a former railway station platform, with the off-site Trans Pennine Trail (TPT) running along the route of the dismantled railway line.

Soil bunds are present along the northern and western boundary.

Surrounding Uses

Activities within the immediate surrounding area are as follows:

- North – Trans Pennine Trail, beyond which are former mineral workings and Stairfoot Landfill Site associated with the former Stairwell Brickworks.
- East – Trans Pennine Trail, residential properties, former mineral workings and Stairfoot Quarry No.2 landfill associated with the former Stairwell Brickworks, two past void spaces that are now Ponds, the village of Ardsley.
- South – Wombwell Lane, residential properties, Eden Memorials (monument makers), agricultural land and woodland.
- West – H&H Metal Recycling and Wombwell Lane; beyond which is Barnsley Trade Park and Barnsley Retail Park (numerous commercial / warehouse units), including a petrol filling station (approximately 70m distant) and agricultural land.

Bulk Storage of Chemicals and Hazardous Substances

Underground Storage Tanks (USTs)

The facility representative was not aware of the current or former presence of USTs at the site and no visual evidence of USTs, such as fill points, pumps, gauges, or signage, markings or concrete scarring indicative of such potential uses was identified during the visit.

Above Ground Storage (ASTs)

The facility representative was not aware of the current or former presence of ASTs at the site and no visual evidence of ASTs, such as fill points, pumps, gauges, or signage, markings or concrete scarring indicative of such potential uses was identified during the visit.

A metal pipe was located in the south-east of the site, the purpose of which was unknown.

Water, Wastewater and Drainage

Services to the site including the mains water supply have been isolated to the site boundary.

No groundwater or surface water is abstracted at the site.

A drainage plan dated November 2021 for the site has been provided to Ramboll by the Client. The plan shows the historical drainage routes extracted from Fennell, Green & Bates IPPC Plan dated January 2004. Some of the routes appear to be isolated indicating that there may be blocked/damage drains unable to trace. One route appears to start off-site in the north and crosses the north-western part of the site, which may be a surface water culvert as indicated by the site contact. Although no pipe dimensions or flow pathways are indicated on the drawing. Ramboll obtained a statutory asset location plan from Yorkshire Water, dated October 2023. The plan shows details of Yorkshire Water assets in the area including a 300mm vitreous clay surface water sewer flowing on to the site from the north.

No oil-water interceptors were reported to be present on site or observed on-site by Ramboll during the site visit; and none are shown on the drainage plan provided by the Client.

No current issues in relation to flooding were reported by the facility representative during the site visit. The site contact said that previously there were issues in the centre of the site due to a blocked drainage run. The client undertook repair work to the drainage in this area and no further incidents have occurred.

The appropriate management of water, wastewater and drainage contribute to supply of clean drinking water and protection of water resources from pollution¹.

Waste Management

Wastes generated on-site are limited to green waste from landscape maintenance. The green waste is burned on-site, evidence of a bonfire was observed on hardstanding during Ramboll's visit.

Fly-tipped materials including green waste (tree cuttings) and plastic pipework were observed on the southern site boundary during the visit.

Good management of wastes contribute to improved resource management and minimises risk of pollution².

¹ Sustainable Development Goal 6: Clean Water and Sanitation

² Sustainable Development Goal 12: Responsible Consumption and Production

Deleterious Materials

Asbestos Containing Materials (ACMs)

There are no buildings currently located on-site. The site contact reported that asbestos materials have previously been fly-tipped near the entrance of the site. Comprehensive Asbestos Removal Ltd were instructed by the Client in April 2022 to undertake removal of the fly-tipped ACMs and carry out a hand picking exercise across the site.

During Ramboll's site visit a fragment of potential ACM (cement roof sheeting) was observed on the surface of a soil bund in the north-west of the site.

Under the Control of Asbestos Regulations (2012), the duty holder must manage the risk from asbestos on a premises and to develop and implement an ACM management plan, with review and updating as appropriate. The duty holder is the party who has, by virtue of contract or tenancy, the main responsibility for maintenance or repair of the building.

An asbestos survey has not been undertaken by Ramboll and a review of asbestos compliance is outside the scope of this review.

Refrigerant Gases

No equipment with the potential to contain Fluorinated Greenhouse Gases (F-gas) or Ozone-Depleting Substances (ODS) were observed on-site at the time of Ramboll's inspection.

Polychlorinated Biphenyls (PCB)

No equipment with the potential to contain PCBs was observed on-site at the time of Ramboll's inspection.

Emissions to Air

No significant emissions to air were noted.

Other Issues

According to the site representatives, there is no known history of complaints, enforcements or other regulatory actions regarding the site or immediate surrounding properties related to environmental conditions. No spill events were reported. The site burns green waste in a bonfire located an area of hardstanding in the central-eastern area of the site.

According to the site representative an area in the centre of the site previously suffered from flooding during periods of heavy rain. Subsequently, investigative work was undertaken by the Client on the surface water drainage with the drainage runs cleared and repaired.

Facility personnel confirmed that an environmental ground investigations had taken place in 2021 and a series of monitoring boreholes were identified by Ramboll during the site visit. Several of the monitoring wells had been damaged with the protective covers removed through vandalism.

Japanese Knotweed had previously been identified by on the north-western site boundary.

According to the site representative, this was identified approximately two years ago and underwent a treatment programme of herbicides, prior to excavation and burial in the north of the site and subsequent further burial under a soil bund.

5. HISTORICAL INFORMATION

Ramboll has undertaken a review of historical mapping and aerial imagery, the findings of which are summarised below. Selected historical maps are presented in Appendix 2.

The Site

The 1854 map showed the majority of the site was undeveloped agricultural land. A Railway (South Yorkshire Railway) passed through the centre of the site in a west to east orientation. Two Culverts were present in a north-east to south-west orientation; one to the western boundary and one through the centre of the site. Mapping from the 1890s showed three Junctions denoted on the Railway; Penistone Junction to the west, New Oaks Junction and Woodburn Junction to the east. The Culvert on the western boundary was no longer annotated. The map of 1906 noted the Railway and Stairfoot Brick Works. A large Clay Pit was also shown in the centre of the site. Penistone and Woodburn Junctions were no longer depicted.

Maps from 1931 and 1938 show the Stairfoot Brick Works and Clay Pit have been extended, with a Tunnel passing under the Railway allowing access from the Brickworks to the Clay Pits. A newer Clay Pit was shown in the central northern area of the site extending off-site. North of the Railway a rectangular building was present with lines labelled as London North Eastern Railway Mexborough & Barnsley. The mapping of 1948 depicted the building footprint to be unchanged. Maps from 1955-1956 showed a Tramway through the northern section of the site with two ponds: one in the

southern section of the site accounting for approximately 7% of the total site area and the other smaller pond encroaching into the northern boundary. The 1968-1984 map do not clearly show the site; however, a Refuse Tip was identified encroaching onto the northern section of the site (1968) and a Pond to the eastern boundary and the Clay Pit in the south of the site were labelled as disused (1970).

Mapping from the 1980s depicts the building south of the Railway to have expanded (approximately 8% of the site area) with three associated Tanks. An Electricity Substation was present in the south of the site adjacent to Wombwell Lane. By the 1990s, a new smaller rectangular Building was located near the site entrance, and the Clay Pits in the north-west and north-east of the site and the Railway labelled were dismantled. By 1993, the Brickworks building north of the Railway had been demolished and a second Electricity Substation was present. An Aerial Image from 1999 showed the site to be in a similar configuration to the present-day, with the grassy area to the south, hardstanding in the central areas and barren landscapes to the north and north-west (it appears the northern Clay Pit has been infilled but the north-western Clay Pit was still being used). Numerous shipping containers were located in the centre, south-east and south. The two former Ponds were no longer depicted.

Google Earth Imagery from the 2000s shows little change to the building footprint, although the former Clay Pit to the north appeared to be used to stockpile materials. By 2009 this area appears to have been levelled. By 2016, the Brickworks building had been demolished and the site was unused. Google Street View images from 2017 showed a fire engine at the entrance to the site. From this point, there are no further changes depicted.

The Surrounds

The 1854 map shows the surrounding area was undeveloped agricultural land. The Dearne and Dove Canal was 170m south-west at its nearest point and Stairfoot Brick Yard 280m west.

The 1890s mapping shows a separate Railway junction has been constructed (adjacent to the east) and Coke Ovens were shown 20m north-west, associated with the New Oaks Colliery up to 350m north-west. By 1906, a row of terraced houses were present 10m south and the New Oaks Colliery had expanded. Manor Flint Glass Works was depicted 420m west.

1931 and 1938 mapping depicts the central large Clay Pit extension off site to the east; a Tramway was annotated adjacent to the southern boundary associated with the Brick Works and the Coke Ovens (20m north-west) along with the New Oaks Colliery no longer labelled. The Oaks Chemical Plant was now shown from 110m north-west, with numerous rectangular Tanks. By 1948, the Clay Pits had extended to 120m east and 280m north-west and by 1955-1956 the Tramway extended 290m north to the edge of a Clay Pit. By 1962, the adjacent Clay Pit extended to 120m east was labelled as disused. A Football Ground was now adjacent to the north-east and a Garage located south-west. Oaks Chemical Plant was now labelled as Works, but structures associated with the Works were apparent from 60m north-west and now included two Gasometers and more rectangular Tanks. The northern Clay Pit is now present up to 340m north of the site (1962) and the Refuse Tip depicted in the 1968 mapping extended to 50m east. By the end of the 1970s, most of the Clay Pits appears to be disused and infilled with waste.

Mapping from the 1980s showed the former Oaks Chemical Plant (from 60m north-west) to have been demolished and the northern Clay Pit extending further to north-east. The surrounding area now comprises more residential properties to the south-east, with mainly agricultural land to the south and west, with the northern landscape mostly being affected by the Clay Extraction Pits. The Dearne and Dove Canal (170m south-west) is now labelled as disused. The 1990s mapping showed numerous small rectangular Works adjacent to the north-western corner and a Pumping Station (sewage) 100m south. The structures associated with the present-day Barnsley Trade Park were also depicted, including the Tesco branded petrol filling station (PFS) 70m west.

Google Earth Imagery from the 2000s depicts the former Clay Pits to the east and north to be vegetated with grass. From 180m east, an area appears to have been used as a stockpile. By 2009 the area appears flattened and by 2016 the area is filled with water, which is still apparent in present-day mapping and Aerial Imagery.

6. ENVIRONMENTAL DATABASE INFORMATION

The following information has been obtained from review of an environmental database.

Data Type		Distance				Relevant records within 250m of the site
		On Site	<250 m	250-500m	500m-1km	
Contaminated Land Register entries		0	0	0	0	None
Pollution incidents		0	1	2	3	Release of unknown sewage 130m south-west of the site in September 1989 and was classed by the EA as a Category 3 Minor Incident.
Prosecutions or enforcement actions		0	0	0	0	None
Recorded landfill sites		0	1	0	1	Nearest current landfill is B.D.R Waste Disposal Ltd locate 230m north that accepts soil and subsoil and the maximum input rate is very small (<10,000 tonnes per year).
Historical landfill sites		5	2	0	4	There are records of five former landfills on-site relating to the Stairfoot Brickworks. Stairfoot Quarry landfill (encroaching onto 30% of the eastern area of the site) operated by The Yorkshire Brick Company. The landfill accepted inert, industrial, commercial, household and liquid sludge between January 1978 and December 1982. Disused Railway Cutting landfill (adjacent to Quarry Landfill) that was operated by William Gosney Ltd that accepted inert and commercial waste between May 1985 and May 1991. Stairfoot Quarry No. 2 encroaches onto the central northern section of the site (10% of the total site area) operated by Barnsley Metropolitan Borough Council. The landfill accepted inert, industrial, commercial, household, special and liquid sludge between April 1982 and December 1987. Stairfoot Landfill Site (North Quarry) encroaches onto the north-west of the site (less than 5% of the total site area) operated by Barnsley Metropolitan Borough Council. The landfill accepted inert, industrial, commercial, household, special and liquid sludge between December 1986 and December 1992. Stairfoot Brickworks North Quarry Phase II (adjacent to North Quarry), operated by Barnsley Metropolitan Borough Council. The landfill accepted inert, industrial, commercial and household waste between July 1991 and the end date is not provided.
Licensed waste management facilities		0	0	0	2	Closest is Swaithe House Farm licensed for household, commercial and industrial waste located 820m south.
Environmental Permits	Part A(1)	0	0	0	0	None
	Part A(2)	0	0	0	0	None

	Part B	1*	2	1	5	*Historic Permit issued to Hansons Building Products for manufacturing heavy clay goods. Closest active Permit is Tesco stores (70m north-west) for a petrol filling station.
Control of Major Accident Hazards Sites (COMAH)		0	0	0	0	None
Fuel stations		0	1	0	0	Tesco branded (70m north-west)
Contemporary trade directory entries		0	3	6	10	Nearest 30m south-west (Halfords)
Registered radioactive substances		0	0	0	0	Information on certain radioactive substance authorisations is not publicly accessible
EA discharge consents		1	2	0	5	Discharge Consent on-site held by Yorkshire Water Services – Pumping Station for the discharge of Sewage into a tributary of Dob Dyke
Radon affected area (Y/N)		Y	-	-	-	60% of site is located within an area where 5% and 10% of residential properties are projected to contain radon above the residential action threshold, including the south-east of the proposed site layout

According to the environmental database the site lies in a “Radon Affected Area” as defined by Public Health England. The site is recorded as being located in an area where between 3% and 5% (north and western area of the site) and 5% and 10% (south and eastern area of the site) of residential properties are projected to contain radon above the residential action threshold).

According to BRE Report BR211 (2015) Radon: Protective Measures for New Buildings; basic radon protection measures are considered necessary during the construction of new buildings or extensions in the affected areas. These guidelines refer to residential dwellings and can be considered conservative for commercial properties. The Action Level for commercial properties is 300 Bq/m³ and assessment of potential worker exposure is the responsibility of the occupant.

Under Health and Safety legislation, employers have a duty to manage workplace risks including the potential for radon exposure. Health and Safety Executive guidance recommends radon monitoring for workplaces located in Radon Affected Areas. If the workplace radon threshold is exceeded, the Ionising Radiations Regulations 1999 require employers to take action to reduce risks.

The LinesearchbeforeUdig database, which lists pipelines distributing crude oil and refined hydrocarbon products owned and/or operated by a number of UK pipeline operators indicates that there are no records of underground oil or refined hydrocarbon product pipelines on the site or within 250m.

The site has a low risk from Unexploded Ordnance (UXO), using online information from Zetica UXO database³. A low risk area is indicated as having a bombing density of 15 bombs per 1000 acres or less; furthermore, the mapping does not show any UXO finds within a 1km radius of the site.

A pre-desk study assessment of the site has been undertaken by Zetica UXO (dated 13 March 2024) which confirmed the following:-

- There was no identified pre-WWI, WWI or WWII military activity on or affecting the site.
- WWI and WWII strategic targets within 5km of the site included transport infrastructure and public utilities; industries important to the war effort (including munitions factories, and chemical, engineering and metal works); and military camps and training areas.
- No WWI bombing has been identified on the site. During WWII, the site was located in the County Borough of Barnsley and was adjacent to the Urban District of Worsborough. Both Barnsley and Worsborough officially recorded no High Explosive bombing. No readily available records have been found to indicate that the Site was bombed.

³ <https://zeticauxo.com/guidance/risk-maps/>

- Zetica note that a detailed UXO desk study, whilst always prudent, is not considered essential in this instance.

7. ENVIRONMENTAL REGULATORY AUTHORITY INFORMATION

Planning Department

Ramboll has obtained information on planning applications relating to the site from online records of the Local Authority Planning Department. Relevant applications are summarised as follows:

- Ref. B/75/0974/BA: Restoration of disused quarry by disposal of colliery waste from Darfield Main Colliery and use of part of the restored area as a vehicle park. No further information provided.
 - Ref. B/76/3527/BA: Deposit of household commercial and industrial waste. No further information provided.
 - Ref. B/77/1293/BA: Erection of a building for the manufacture of building bricks. No further information provided.
 - Ref. B/79/2163/BA: Modification to part of existing roof of building used for the manufacture of building bricks (Clay loading bay). No further information provided.
 - Ref. B/80/1745/BA: Erection of building for sale of Builders Merchants materials No further information provided.
 - Ref. B/80/1151/BA: Erection of garage for repair facility. No further information provided.
 - Ref. B/82/0042/BA: Temporary use of land for brick stocking (Expired on 12/03/1985.). Applicant: Yorkshire Brick Company. No further information provided.
 - Ref. B/83/0282/BA: Installation of landfill gas recovery system. Approved 4th May 1983. No further information provided.
 - Ref. B/84/0534/BA: Installation of landfill gas recovery system. Approved 1st June 1984. No further information provided.
 - Ref. B/85/0780/BA: Construction of 100mm diameter leachate pumping main. Approved 11th October 1985. No further information provided.
 - Ref. B/87/1353/BA: Extension to existing landfill gas recovery system. Approved 4th February 1988. No further information provided.
 - Ref. B/88/0738/BA: Disused railway line for brick and clay stocking. Approved 15th March 1991. No further information provided.
 - Ref. B/93/0247/BA: Registration of Interim Development Order Permission. Winning and working of minerals. Valid from 6th January 1994. No further information provided.
 - Ref. 2007/1069: Variation of Condition 1 of planning consent B/93/0247/BA to extend extraction and restoration period. Applicant: Hanson Building Products Limited. Approved with Conditions on 8th June 2007, none in relation to contaminated land; although restoration scheme plan included on documents.
 - Ref. 2022/1218: Enabling works consisting of the erection of perimeter security fencing, entrance gates and associated tree works. Applicant: Mr Bryn Hopkins. Application currently under consideration.
 - Ref. 2023\ENQ\00330. New glass recycling and repurposing facility.
- Some applications also relate to off-site areas, including the restoration of land and installation of landfill gas recovery systems.

Environmental Health Department

Ramboll has requested information from the Environmental Health Department of the Local Authority and this is awaited.

Petroleum Enforcement

Ramboll requested further information from South Yorkshire Fire & Rescue regarding historic petroleum storage at the site. The Petroleum Officer confirmed that the Authority hold no records of past or current petroleum storage at the site.

8. ENVIRONMENTAL SETTING

Geology and Hydrogeology

According to British Geological Survey (BGS) 1:50,000 mapping of the area, the site is not directly underlain by Superficial Deposits. The bedrock geology comprises Pennine Middle Coal Measures Formation (mudstone, siltstone and sandstone, a Secondary A Aquifer). The Oaks Rock (a named sandstone sub-unit of the Coal Measures) is located in the south-eastern and eastern area of the site (approximately 13% of the total site area).

Publicly available ground investigation records indicate the geology at the site comprises:

- Made Ground (variable, but includes ashy soils, plastic, brick, glass, paper, wood, putrescible materials, domestic waste) up to 11.5m below ground level (bgl);
- Pennine Middle Coal Measures (comprising grey / brown sometimes weathered mudstone / siltstone) proven to 12.45m bgl. A layer of silty clay was often encountered above the Coal Measures which represented very weathered bedrock. The Oaks Rock Sandstone Formation is present within the extremely south-east of the site.

A geological fault passes through the site in a west to east direction across the southern section of the site. The fault down throws to the north.

The BGS map also indicates a fossil horizon (marine band) runs through the site in a north-west to south-east direction and passes through the north-eastern area of the site.

According to Coal Authority information presented in the environmental database, the site is located in a Coal Mining Affected Area. The Coal Authority Interactive Map does not show the site to be in a mine entry zone of influence or Development High Risk Areas. The BGS has stated that the site is located in an area where other (non-coal) mining activities are highly unlikely.

A Coal Mining Report (dated 29 April 2020) was provided by the Client.

- According to a report from The Coal Authority the site is in an area that could be affected by underground mining in 10 seams of coal at depths between 190m and 650m bgl, last worked in 1990. Any movement in the ground due to coal mining activities associated with these workings should have stopped by now.
- The site is not located in the likely zone of influence from present underground coal workings, and is not within an area that the Coal Authority is determining whether to grant a licence to remove coal using underground methods. However, reserves of coal exist in the local area which could be worked at some time in the future.
- There are no known coal mine entries within 20m of the site.
- The Authority is not aware of any evidence of damage arising due to geological faults or other lines of weakness that may have been affected by coal mining.
- The site does not lie within the boundary of an opencast site from which coal has been removed by opencast methods in the past, within 200m of the site presently and within 800m of an opencast site that the Coal Authority is determining to grant a licence to remove coal by opencast methods.
- The Coal Authority has not received a damage notice or claim for the site or any property within 50m since 31st October 1994, and there is no current Stop Notice delaying the start of remedial works or repairs to the property.
- There is no record of a mine gas emission requiring action by the Coal Authority within the boundary of the site.
- The has not been subject to remedial works, by or on behalf of the Authority, under its Emergency Surface Hazard Call Out Procedures.

The Environment Agency (EA) classifies groundwater at the site (relating to the Don & Rother Millstone Grit & Coal Measures Water Body) as being of 'poor' chemical quality and quantitative status under the Water Framework Directive classification scheme.

Groundwater flow was interpreted to be from north and north-west to south and south-west in a previous ground investigation.

Two BGS Recorded Mineral Sites are recorded for the site, both relating to Stairfoot Brickworks which mined common clay and shale from the Pennine Upper Coal Measures Formation via opencast methods. Within 250m were two other clay and shale extraction pits and one deep Coal underground mine (relating to the New Oaks Colliery Shaft 250m north-west).

There are records of three licensed groundwater abstractions within a 2km radius of the site as detailed below.

Distance	Purpose	Source
1.01km E	General Farming and Domestic	Not stated
1.04km NE	General Farming and Domestic	Not stated
1.14km NW	General Washing	Superficial Drift

The site is not situated within a designated groundwater Source Protection Zone.

Hydrology

The nearest identified watercourse is Dob Sike, located 110m south-west at its nearest point. There are also two surface water bodies, which appear to be infilled former Quarry Pits workings located 170m east and 220m north.

The EA classifies surface water catchment (Dove from Source to River Dearne Water Body) as being of 'fail' chemical quality and 'moderate' quantitative status under the Water Framework Directive classification scheme.

According to the environmental database records there is one licensed surface water abstraction within a 2km radius of the site, as detailed below.

Distance	Purpose	Source
1.96km SW	Top Up Water	River Dove

There may also be smaller scale (unlicensed) abstractions within 2km of the site.

Regulatory Flood Designations

Regulatory flood maps have been developed to be used in strategic planning and are not intended to provide site-specific information. However, the mapping can provide a useful indication of whether further consideration or assessment of flood risks to a site may be required.

Fluvial

According to the EA's fluvial flood map for planning, the site is located in Flood Zone 1 (low probability). This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1% in any year).

Surface Water

According to the EA Flood Map for Surface Water which presents the theoretical potential for flooding from pluvial sources (i.e. flooding caused by rainwater exceeding capacity of drainage systems), the site is located in an area of mixed surface water flooding probability:-

- Approximately 60% of the total site area (areas of hardstanding and soft landscaping to the north, far west and south-east of the site) is located in an area of Very Low flooding probability. This zone comprises land assessed as having a less than 1 in 1,000 annual probability of pluvial flooding (<0.1% in any year).
- Approximately 10% of the total site area (area of soft landscaping north of the hardstanding where the former railway used to reside) is located in an area of Low flooding probability. This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of pluvial flooding (1% – 0.1% in any year).
- Approximately 5% of the total site area (loose gravel area east of the hardstanding) is located in an area of Medium flooding probability. This zone comprises land assessed as having between a 1 in 100 and 1 in 30 probability of pluvial flooding (3.3% - 1% in any year).
- Approximately 25% of the total site area (north-west of site and loose gravel area east of the hardstanding) is located in an area of Very High flooding probability. This zone comprises land assessed as having a 1 in 30 or greater annual probability of pluvial flooding (>3.3% in any year).

Surface water drainage networks are typically designed to accommodate only a 1 in 30 (3.3%) annual probability rainfall event. Older drainage networks may have a lower capacity, especially if they have not been maintained adequately. Although not true of every situation, surface water flooding is typically relatively shallow and would be expected to subside following the storm event assuming drainage assets are maintained in an appropriate condition.

Designated Ecological Sites

Stairfoot Brickworks is a designated Site of Special Scientific interest and is located at the eastern end of the site and Dearne Valley Park is a designated Local Nature Reserve (located 1.69km north-west).

There are also three Green Belt areas within 2km of the site (closest is 15m south-west) and two Nitrate Vulnerable Zones (closest is the River Dearne NVZ pertaining to surface water located on-site) within 2km of the site.

9. REVIEW OF PREVIOUS REPORTS

The following reports have been provided to Ramboll for review:

- Geological, Planning and Environmental Consultants, August 2011: Phase 2 Contaminated Land Ground Investigation for Stairfoot Brickworks, Barnsley;
- SLR Consulting Ltd, October 2012: Stairfoot Landfills Landfill Gas Pumping Trial (Ref 406-00027-00335);
- Ashton Bennett Consultancy, October 2021: Site II Site Investigation at Proposed Cullet Recycling Facility, Wombwell Lane, Barnsley, S70 3NS (PB 3465); and
- Ashton Bennett Consultancy, April 2022: Design of Gas Protection Measures at Proposed Cullet Recycling Facility, Wombwell Lane, Barnsley, S70 3NS (PB 3465/GPM).

Geoplan Phase II August 2011

This report summarises the findings of an intrusive site investigation undertaken on behalf of Hanson UK. The scope comprised:-

- Determine the potential ground-related contamination hazards within the site boundaries that may affect any proposed development; and
- Provide preliminary remediation recommendations and likely additional areas of investigation, if required.

Geoplan produced a separate desk study report issued in July 2011; however, this has not been provided to Ramboll for review.

The intrusive investigation by Geoplan comprised the following:

- Eight exploratory trial holes at a maximum depth of 2.1m bgl
- Soil samples were taken for chemical laboratory testing during the drilling.

Field Observations

Reinforced concrete was encountered in four of the trial pits (TP1 to TP4) to a maximum depth of 0.2m bgl. Made Ground was encountered at all locations from ground level to a maximum depth of 2.0m bgl, which was variable throughout the site but generally comprised gravelly silty sands with brick, ash and tile fill.

The underlying bedrock of the Pennine Middle Coal Measures was encountered in three of the trial pits (TP2, TP3 and TP4) from a minimum depth of 0.8m in TP2 and TP4 proven to a maximum depth of 2.0m bgl.

Groundwater was only detected in TP3 (centre of the former building footprint) in the form of seepage at the depth of 1.3m bgl, at the interface between the Made Ground and underlying Coal Measures clay strata. The report interpreted this to be perched water rather than the regional groundwater table.

The report also alludes to an underground landfill gas pipeline throughout the site.

Soil Assessment

Contaminants were screened against the Environment Agency's CLEA Report default Tier 1 Assessment Criteria (TAC) for a commercial / industrial end use, residential land without plant uptake and residential land with plant uptake. The TAC also included Soil Guideline Values (SGV) for screening.

Samples were categorised in three separate categories: four samples from a silty gravelly sand (Made Ground A); two samples from disturbed / reworked clay or granular spoil (Made Grounds, B,C and D) and no samples were submitted from 'inert material' stone or brick fill (Made Ground E and F).

Residential land without plant uptake

The following exceedances of assessment criteria were detected:

- Arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, dibenzo(a)anthracene and indeno(123cd)pyrene at TP1 at 0.4m bgl;
- Benzo(a)pyrene at TP2 at 0.3m bgl;
- Arsenic, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a)anthracene and indeno(123cd)pyrene at TP3 at 0.7m bgl; and
- Arsenic and benzo(a)pyrene at TP4 at 0.3m bgl.

Residential land with plant uptake

The following exceedances of assessment criteria were detected:

- Arsenic, benzo(a)anthracene, benzo(a)pyrene, benzo(a)fluoranthene, dibenzo(a)anthracene and indeno(123cd)pyrene at TP1 at 0.4m bgl;
- Benzo(a)pyrene at TP2 at 0.3m bgl;
- Arsenic, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a)anthracene and indeno(123cd)pyrene at TP3 at 0.7m bgl; and
- Arsenic and benzo(a)pyrene at TP4 at 0.3m bgl.

Visual / olfactory evidence of potential contamination was encountered in TP1 (Made Ground 0.2m to 0.8m; general appearance); TP3 (0.6m – 1.3m; Made Ground; ash, clinker with a noticeable oil smell on the concrete stained surface) and TP4 (Made Ground 0.2m to 0.5m; ash and concrete stained surfaced).

The report summarised that the ground investigation showed that the site is suitable for future development and that no significant risk to end users in a commercial / industrial development is anticipated. The report recommended that further investigation is needed to determine the ground gas regime at the site and to understand the risk to groundwater is unknown.

Controlled Waters Assessment

No sampling of controlled waters was undertaken as part of the assessment.

Ground Gas Assessment

No ground gas monitoring was undertaken during the ground investigation. However, the report highlighted that the risk was high due to the former land usage of the site.

SLR Landfill Gas Pumping Trial 2012

This report summarises the findings of a landfill gas pumping trial at the site, commissioned by Hanson UK Ltd (Hanson), specifically the areas known as Old Field, South Quarry and North Quarry.

At the time of reporting, the Old Field and South Quarry were for sale. Old Field is located on land that is suitable for development and South Quarry was utilised for pasture. Both the areas contain gas extraction wells and pipework that are linked to a gas flare located adjacent to the Old Field area. The North Quarry is connected to the same gas extraction and flaring system as the two aforementioned areas, although the North Quarry is split into two separate areas of landfill, named North Field Phase I and Phase II. The former was operated by the Local Council (who at the time of reporting held responsibility for the area). The latter is the most recent landfill that was designed and developed as an engineered containment landfill and was operated in two phases by BDR Limited and was then the responsibility of FCC Environment (formerly known as Waste Recycling Group).

The scope of the works was to review Old Field and South Quarry landfill documents and carry out gas monitoring within the two areas. The gas pumping trials were conducted over four separate areas.

Landfill Development and Gas Control System

Old Field

The report details operational periods, along with area, volume, depth and completion dates. The report also provides gas abstraction start dates for Old Field (June 1983) and South Quarry (July 1984). Old Field was operational between August 1977 to August 1978, with the household waste deposited in compacted 2m deep layers, prior to restoration with subsoil and seeded grass for grazing. The thicknesses of the restoration layers were reportedly thin (0.15m and 0.45m in thickness) across the site. The Council also installed a 12m deep concrete ring leachate inspection chamber in the deepest part of the site to alleviate leachate accumulation.

The gas control design within Old Field is reportedly not clear but appears to have relied on conventional vertical gas extraction wells. Pilot tests on three wells in 1981 aided the development of the active extraction system that became operational in June 1983. However, performance was

problematic due to the problem of air ingress through the thin landfill cover and condensate accumulation and blockage in the installed pipework.

South Quarry

South Quarry landfill development followed in 1982. Domestic and trade waste was initially deposited in Phase I, and was subsequently capped with a 2m thick clay cap. Vertical gas extraction wells were installed. During the operational phase of the landfill problems occurred with leachate accumulation that was attributed to the low permeability of the shales at the base of the site, forming a high degree of natural containment. This was further excavated by the accumulation of groundwater through the water-bearing layers of sandstone strata above. During the infilling of Phase II another landfill gas approach was attempted, with a larger surface area that allowed the installation of horizontal gas collection pipework to be trialled. The design system comprised ten vertical gas extraction wells drilled into the waste, and these were 0.2m in diameter and were completed with 0.1m pipe and gravel surrounding. The pipes were drilled to a depth of between 10 to 15m bgl with the top 5m of the pipe being the unperforated pipe. This, combined with the 2m clay cap reduced the problem of air ingress encountered during the Old Field design. Another approach was trialled during the design system of South Quarry Phase II, utilising horizontal gas collection wells. The system comprised wells at approximate 30m spacing laid horizontally in layers of waste, each 2m thick. Long lengths of collection pipe (170m long) laid in trenches and collected to the gas collection system could consequently accumulate gas. Brick rubble sourced from the site was used as infill around the pipework and gas wells. The leachate accumulation problems still occurred during Phase II. Control measures included the use of clay to seal groundwater ingress, construction of leachate drains to channel liquid away from the waste, leachate recirculation and leachate collection and disposal to foul sewer to reduce volumes contained within the site.

The report indicates the North Quarry Phase I excavation was dry and was expected to remain dry during excavation as the water-bearing Mansfield strata had not been encountered or breached. SLR concluded they were not aware of water-bearing ingress in Phase I, when the unlined clay pits were infilled with waste by the Council between 1987 and 1991. The gas design control measures were reportedly the same as the South Quarry Phase II design. The infilling of North Quarry Phase II by BDR followed in 1993 until 1995 when tipping ceased at Stairfoot. The Phase II area was designed and constructed as an engineered containment landfill. SLR confirmed they have not reviewed the design specification and development and operational details surrounding the landfill. Phase II was substantially smaller than Phase I, but it extends closer to sensitive receptors (residential housing close to the northern boundary).

Landfill Gas

Historically, landfill gas was used to fire the tunnel kilns that produced bricks at the Brickworks following successful initial trial carried out at Old Field in 1981. The company identified the landfill gas was produced by the biological breakdown of domestic waste deposited in the adjacent Quarry voids. The use of the landfill gas accounted between 20-30% of the total gas volume extracted from the site at the time. The landfill gas was found to be best suited within the medium temperature parts of the kiln (between 870 to 960 degrees Celsius). The system operated 24 hours a day and 50 weeks a year (shutting down for two weeks during Christmas). The landfill gas at the time had a typical methane content of between 44-48% by volume was flared on-site at a rate of 350m³/hour.

The SLR report provides a review of an audit and review of the gas collection system on behalf of Hanson by Renewable Power System (RPS) in 2005. RPS visited the site on four occasions during July to September 2005 to inspect and monitor the gas extraction system for the whole of the Stairfoot landfill complex.

Old Field

RPS estimated that Old Field comprised 100,000 tonnes of domestic waste deposited between 1977 to 1983 and was not contributing gas to the kilns during the visit as the inlet valve was closed. No suction was recorded on wells OF1 to OF5; and no significant gas concentrations were recorded in any of the wells. RPS' gas model indicated that the gas production had ceased in 1997 and recommended in 2005 that the extraction system be decommissioned and wells converted into passive venting.

South Quarry

RPS estimated that South Quarry received 325,000 tonnes of domestic, industrial and commercial waste between 1982 to 1986. At the time of the visit, South Field was contributing little or no gas volume to the kilns, the inlet valve was observed to be 'cracked just open'. Wells V7-V10 and H5 were disconnected and were buried (no readings were consequently taken). Slight suction was

recorded on several other wells and gas concentrations varied between 0-60% methane by volume. RPS' gas model indicated that the gas production had ceased in 2005 and recommended in 2005 that the extraction system be decommissioned and wells converted into passive venting.

North Quarry Phase I and Phase II

Phase I was operational between 1987 and 1991 with 320,000 tonnes of waste deposited by the Local Council. Phase IIA and IIB was developed between 1993 and 1996, landfilling a total of 100,000 tonnes of waste. RPS recorded some blockages on sample lines, giving false high suction readings; this corresponded with gas concentrations ranging between 0.3 and 71.4%. RPS gas model indicated that the North Quarry area were the main contribution to gas production in 2005 and that it peaked at 302m³/hr in 1997 and would cease in 2014.

Current Landfill Gas Control

Reporting in 2012 indicated the current gas control operated on a weekly cycle with the extraction switched on for an eight hour period each Friday. The flare is manually lit and burns continuously with a slight haze during the period of pumping.

Within Old Field, in addition to the gas extraction wells there was reportedly a perimeter gas cut-off barrier located on the south-west boundary close to a row of terraced cottages. Hanson reportedly had little knowledge as this passive system was installed by the Council. Monitoring along this boundary of Old Field was previously carried out using an automated telemetry system. The monitoring was carried out around the north-eastern perimeter of South Quarry but those boreholes are reportedly buried. No current gas monitoring was being conducted at the time of the reporting.

North Quarry Phase I reportedly had associated infrastructure that resembled gas monitoring boreholes to the west; however, SLR was unable to fully vindicate this. SLR contacted the Council to ascertain whether there was ongoing gas monitoring but it was deemed not clear whether the infrastructure was suitable for the purpose. There are a series of gas monitoring boreholes located along the northern boundary of North Quarry Phase II that are routinely monitored by FCC. The monitoring data indicated there were not any issues of gas migration from the engineering containment landfill to the houses beyond.

SLR Landfill Gas Monitoring

SLR modelled gas yields throughout the site using the GasSim software from a scenario based from 2010 to 2030. The following data was presented graphically and is summarised below:

Bulk Landfill Gas (m³/hr)	2010	2020	2030
Old Field	13	7.25	4.25
South Quarry	80	45	26
North Quarry Phase I	105	58	33
North Quarry Phase II	36	19	11

The gas modelling carried out by SLR predicted that available total landfill gas yields from the four combined areas were 207m³/hr at the time of reporting. Predicted breakdown from the modelling of each area gives an average of: Old Field 12m³/hr (6%), South Quarry 71m³/hr (34%), North Quarry Phase I 92m³/hr (45%), North Quarry Phase II 32m³/hr (15%).

Landfill Gas Pumping Trial

Following the modelling results, a landfill gas pumping trial was undertaken to:-

- Determine the sustainable rate of landfill gas that can be extracted from the whole of the site to enable a suitable size and specification of replacement gas extraction and flaring system to be specified to meet current and future requirements; and
- Determine what proportion of extractable gas was being collected from each separate area of the landfill.

Prior to the gas pumping trial, based on valve settings and gas readings, SLR confirmed it was most apparent that the bulk of the landfill gas extracted from the site was being drawn from the North Quarry Phase I and Phase II. The valves on South Quarry gas field were barely open and ones from Old Field gas field being shut off during the pumping trial.

The report states that it was noted by SLR (and previous by RPS in 2005) that the current gas flare does not meet current standards for the combustion of landfill gas. In terms of gas monitoring, the only ongoing area was the northern perimeter of the lined North Quarry Phase II where flammable gas was not detected during routine monitoring by FCC.

SLR stated that there was insufficient gas monitoring data to determine whether the landfill gas is being contained within the Stairfoot landfill boundary; however, SLR stated that there is no indication that gas is not being contained within the site.

The results from the gas pumping trial by SLR concluded there was insufficient gas production to justify continued gas extraction and flaring. Gas flow readings indicated there could be up to 248m³/hr of gas passing through the flare, although it was considered likely that lower flow rates would be necessary to maintain flare combustion.

The trial concluded a replacement flare with a capacity of 250m³/hr and a 5:1 turn down ratio would be sufficient and appropriate to replace the existing unit at the time of reporting. The location suggested to position the upgraded gas flare would be at the converge of the North Quarry and South Quarry.

Flow readings taken during the pumping trial indicated the total gas flow was 194m³/hr and the individual landfill contribution was:

- Old Field 0m³/hr (0%)
- South Quarry 83m³/hr (42.7%)
- North Quarry Phase I 75m³/hr (38.7%)
- North Quarry Phase II 36m³/hr (18.6%).

The gas pumping trial along with the gas modelling compared favourably. Average readings from both sets of data indicates the percentage for the relevant landfills:

- South Quarry 41%
- North Quarry Phase I 42%
- North Quarry Phase II 17%

Although gas was being recorded in Old Field, the contribution was very low and gas flows were not recorded during the pumping trial. SLR suggested this may be due to infrastructure problems. The residential properties and history of gas migration suggested that some form of gas control was still needed within the area. Gas production was predicted to fall to around 100m³/hr by 2025 and 75m³/hr by 2030. SLR suggested that the newly installed gas flare with a capacity of 250m³/hr with a 5:1 turn down ratio this could potentially reduce the gas quantities as low as 50m³/hr (although unlikely due to the quality of methane in the gas may have declined further and the calorific value of the gas would therefore be too low to maintain combustion).

SLR then went on to provide prices for replacement flares or hire flares for the site; along with suggested further site investigation and monitoring of Old Field.

Ashton Bennett Phase II October 2021

This report summarises the findings of an intrusive site investigation undertaken on behalf of Potters-Ballotini Ltd. The scope comprised:-

- To establish the geological conditions in the vicinity of the site;
- To assess the ground and groundwater conditions at the environmental nature and engineering properties of the strata beneath the site in order to design foundations for the proposed development; and
- To determine the levels of methane and carbon dioxide gases on the site.

Desk-Top Element

The Ashton Bennett report summarises the findings of a Phase I Desk Study by AC Environmental in March 2021 (Ref AC00184/PB/S1PRA_HS-ASCR v 1.0).

The desk-top element of the report contained a full description of the site and site history. The historical mapping was occupied by Railway Lines and Clay Pits associated with the Stairfoot Brickworks on-site. These clay pits were infilled with domestic waste and colliery waste from Darfield Main Colliery and other waste.

Further information described by Ashton Bennett includes a summary of the previous ground investigations and Landfill Gas Pumping Tests at the site (see Section 6).

Intrusive Investigation

The intrusive investigation by Ashton Bennett comprised the following:

- Seventeen window sampler percussion boreholes (WS1 to WS17) to a maximum depth of 7.15m bgl.
- Eleven cable percussive boreholes (CP01 to CP11) to a maximum depth of 12.45m bgl.

- A supplementary investigation was undertaken in the area of the proposed office development which comprised two further window sampler boreholes (WS18 and WS19) and two additional cable percussive boreholes (CP12 and CP13)
- Soils were taken for geotechnical and 'contamination' laboratory testing during the drilling.
- Fourteen rounds of gas monitoring.
- One round of water monitoring (groundwater and surface water).

Field observations

The ground conditions encountered over the majority of the site were Made Ground (between 0.0m – 11.5m bgl in CP03), overlying sandy clay (weathered bedrock) further overlying mudstone or siltstone / sandstone associated with the Coal Measures. Thirteen of the exploratory holes encountered concrete to a maximum depth of 0.30m bgl.

Sixteen locations were installed with a dual groundwater / gas monitoring standpipe; a total of fourteen ground gas monitoring rounds (include groundwater monitoring) were undertaken and one round of groundwater sampling occurred following the completion of the ground investigation.

Perched groundwater was detected in most of the boreholes and groundwater monitoring over seven months determined the groundwater flow to be from north and north-west 50m above Ordnance Datum (AOD) to south and south-west (45m AOD).

The site was divided into four areas:

- Eastern section – the old landfill area of the former Pond in the east of the site
- North and north-western section – northern area of the infilled land and the western extension of the site
- Central – central area where development will take place of the new facility including the workshop and car and lorry park
- Area for proposed offices adjacent to Wombwell Lane

Eastern Area

Boreholes in this area encountered up to 11.5m (CP03) of Made Ground (comprising plastic, glass, red brick, paper, wood and other decomposing materials generally in a matrix of black fine ash with a strong organic odour and in places a hydrocarbon odour). Some locations also encountered concrete up to 0.3m in thickness. Groundwater was encountered at depths between 2.0m to 6.0m bgl in the Made Ground strata.

The Made Ground was classified as domestic refuse.

North and North-western Area

Boreholes in this area encountered up to 6.45m of Made Ground (WS8) generally comprising silty and sandy clay with sandstone gravel and brick, black ash and clinker and waste clay. There was no concrete cover or domestic waste located in this area.

Central Area

Boreholes in this area encountered up to 0.21m of concrete cover underlain by Made Ground extending to depths of 1.30m bgl (CP07) comprising reworked clay and sand with brick fragments, ash, clinker and coal. The Made Ground was underlain by sandy clay representing the weathered bedrock and extended to 3.50m bgl.

Area for Offices

This area is close to the southern boundary of the site and is higher than the majority of the proposed build areas. Boreholes in this area encountered up to 7.7m of Made Ground underlain by mudstone proven to a maximum depth of 7.95m bgl.

Soil Assessment

Contaminants were screened against Soil Screening Values (SSV) derived from the Contaminated Land Exposure Assessment (CLEA) guidance by the EA for an adult as the critical receptor with exposure over a lifetime.

45 soil samples were submitted for chemical testing; 26 samples were tested for heavy metals, polyaromatic hydrocarbons (PAHs), 25 were submitted for Total Petroleum Hydrocarbons (TPH) and ten samples were selected for sulphate, asbestos, Total Organic Carbon and pH testing. Six soil samples were analysed for asbestos.

No metals, PAHs or TPH concentrations exceeded the SGV values.

pH exceeded the SGV guideline in the sample analysed from CP06.

Asbestos was detected in one of six samples analysed, which comprised chrysotile in a floor tile located in the former office building area (sample A1).

The report concluded that the potential risk associated with contaminated soil is *low to low to moderate*.

Controlled Waters Assessment

Potential pollutant linkages relate to the underlying groundwater body and Dob Sike.

Groundwater sampling was undertaken on a single occasion and there were fourteen further groundwater level monitoring visits, along with samples from "surface water in stream, upper lake and Pond by SSSI". Ten samples were tested for metals, PAHs, TPH, sixteen samples were analysed for Total Organic Carbon, pH and ammonia as N; and fourteen samples were submitted for sulphate testing. The results were screened against Water Framework Directive 2015 Generic Assessment Criteria (GAC). The following exceedances of GACs were encountered:

- Boron at two locations (maximum concentration 2,636µg/l compared to GAC of 750µg/l);
- Nickel at two locations (maximum concentration 59.4 µg/l compared to GAC of 15µg/l);
- Arsenic in three locations (maximum concentration of 14.02µg/l compared to GAC of 7.5µg/l);
- Chloride at two locations (maximum concentration of 198mg/l compared to GAC of 188mg/l);
- Ammonia as N in eleven locations (maximum concentration 80,544µg/l);
- Sulphate at one location (maximum concentration of 2,543mg/l);

Eight PAHs exceedance the GAC at CP01 (maximum concentration of fluoranthene of 12.3µg/l compared to GAC of 0.0063µg/l) and naphthalene exceeded the GAC at CP02 (0.70µg/l compared to GAC of 0.0063µg/l)

The report concluded that no significant risk from the ingestion of contaminated water and the transportation of contaminated groundwater to surface water / groundwater to be a mixed risk (unlikely to affect deeper groundwater due to impermeable clay aquitard and surface water due to distance). However, it was deemed high risk as contamination has affected perched groundwater at the site.

Ground Gas Assessment

Ground gases were recorded over fourteen monitoring rounds.

Methane recorded a peak concentration of 34.8% volume/volume (v/v) and carbon dioxide 16.1% v/v (corresponding with a flow rate of between 0.6 to 1.0 litres/hour (l/hr) at the same location CP01). These elevated concentrations of methane and carbon dioxide were consistently recorded in CP01 coinciding with low oxygen concentrations.

Elevated concentrations of carbon dioxide were also detected in CP02, CP11, WS05 and WS06 on several occasions.

Generally, flow rates were under 1.0 l/hr, with a peak flow rate of 1.1 l/hr recorded in CP02.

Using CIRIA C665 guidance, Ashton Bennett noted that the maximum Gas Screening Value at the site was 0.017 relates to a Characteristic Situation 1 (CS1), i.e. very low risk. However, due to the elevated methane and carbon dioxide concentrations, the gas hazard potential was recommended to be classified as a CS2 (low risk).

Ashton Bennett stated that basic radon protection measures were not required for the new development on the site. Ramboll considers that this should be reviewed given the radon levels for this part of the UK, as detailed in Section 6.

Ashton Bennett concluded that recommendations for protection to all building would be to ventilation of confined spaces in buildings, along with a well-constructed reinforced concrete ground floor slab, a low permeability 1200-gauge gas prevention membrane. Ramboll considers that this should be reviewed in light of the significant gas infrastructure present on the site and additional monitoring is undertaken within the vicinity of the proposed buildings.

Ashton Bennett Gas Protection Measures Design April 2022

This report summarises the findings of a gas protection measures design report undertaken on behalf of Potters-Ballotini Ltd. The scope comprised designing suitable mitigating measures to protect potential impacts from ground gasses from the former landfill on-site to residential properties (houses number 15 to 33 Wombwell Lane) which lie adjacent to the south-east.

The report refers to the site as the 'Old Field Landfill' and reproduces similar information to this Phase I desktop report that shall not be reproduced here.

History of Old Field

The Old Field was formerly one of the several Clay Pits in and around the site used by the Stairfoot Brickworks. This was one of the first Pits around the site to be infilled.

The mapping of 1931 shows the Clay Pit to be extending to the rear of number 15 to 33 Wombwell Lane and later Aerial Imagery show the gardens backing onto the landfill. Therefore, these properties are susceptible to migrating landfill gases into the gardens. It is unknown whether precautions against gas ingress were included into the commercial buildings constructed on the landfill to the east of the houses.

Yorkshire Brick Company (previous site owners) detailed that the area of Old Field as 1.5 hectares with a depth of 9.0m bgl to 12.0m bgl of waste comprising a volume of 130,000m³ pr 100,000 tonnes of waste. Old Field was infilled with waste from 1977 / 1978 and gas extraction started in 1983. Deposited waste was compacted in 2m thick layers and covered with 0.15 to 0.45m of subsoil and topsoil. A 12m deep concrete ring leachate inspection chamber was installed in the deepest part of the site.

Gas was reportedly collected from Old Field and other landfills in the Brickworks to power three tunnel kilns that fired the high-quality bricks that were produced at Stairfoot Brickworks. There were three wells for gas collection in the Old Field area and a gas pipe across the centre linking to a flare immediately west of the field. Barnsley Council installed a cut off barrier at an unknown date to the rear of houses 15 to 33 Wombwell Lane. This was excavated on the feather edge of the waste with a series of gas vents placed at regular intervals and with a plastic membrane on the outer or clean side against natural strata. There are no available details on the construction of the venting trench.

2021 Investigation

The 2021 ground investigation targeted Old Field with two cable percussive boreholes (CP1 and CP2) to determine the depth of the landfill and install monitoring standpipes for gas and groundwater. Boreholes CP3 and CP4 were drilled to the west of Old Field landfill. A summary of the ground conditions is provided below.

Borehole	Made Ground (m bgl)	Clay / weathered bedrock (m bgl)	Mudstone (m bgl)	Siltstone / sandstone (m bgl)
CP1	0.0 – 8.45	-	8.45 – 9.15	-
CP2	0.0 – 9.00	-	9.00 – 9.70	-
CP3	0.0 – 11.50	11.50 – 12.45	-	11.50 – 12.45
CP4	0.0 – 6.00	-	6.00 – 6.08	-

Groundwater was encountered at 6.0m bgl in the Made Ground in CP1 and CP2, and groundwater was encountered between 2.0m and 3.0m bgl in CP3 and CP4 respectively.

CP1 and CP2 were gas monitored during 2021 and 2023 and encountered maximum carbon dioxide concentrations of 17.2% v/v in CP1 and 7.0% v/v in CP2, along with maximum methane concentrations of 39.1% in CP1 and 2.1% in CP2. The higher gas concentrations occurred during 2022. The flow rates peaked at 5 l/hr in CP1 and 1.1 l/hr in CP2.

The gas monitoring data indicates precautionary measures are required to prevent gas migration off-site to the receptors at 15 to 33 Wombwell Lane.

2022 Trial Pitting

In April 2022, four trial pits were excavated along the line of the existing venting trench constructed by Barnsley Council. The trial pits encountered thin topsoil underlain by brick fill with some refuse. At the south-west wall of the trial pits natural strata was encountered. The trial pits extended to 4m bgl but were abandoned due to instability. Natural ground was not encountered at the base of the trial pits.

Design of Mitigating Measures

The report states: *the purposes of in ground gas venting is to: 1) reduce concentrations and emission rates of migrating gas from the ground. 2) encourage movement of gas in the ground away from development by forming a preferential pathway for a gas to vent or be release to atmosphere at chosen locations away from sensitive areas of the site.*

The report opts for passive venting as the controlled release and dispersal of gas from the ground to the atmosphere via a preferential path.

Potters-Ballotini intend to release further land to the house owners at 15 to 33 Wombwell Lane in order to achieve a more consistently straight boundary line and fence; hence, mitigating measures were revised to ensure the safety of the occupants.

Ashton Bennett proposed to seal the existing venting trench with clay to prevent gases from migrating beneath the houses. The west wall against the natural ground will be installed with a methane resistant membrane. The new site boundary was advised to be laid with a methane resistant membrane and a 600mm thick clay seal (1×10^{-9} m/sec permeability) that will be covered in topsoil to prevent gas migrating into the gardens of the existing properties.

The report stated that a new gas venting trench / protection measures should be constructed on the Potters-Ballotini side of the new boundary fence to draw the gases towards the venting trench as they will not be able to escape through the clay trench or clay surface seal. The venting trench was advised to be constructed to sufficient depth to intercept the lowest possible layer through which gas may migrate and keyed into the underlying low permeability stratum. This was expected to be 9m bgl. The trench was advised to be backfilled with a granular material of high permeability to gas relative to the surrounding ground (e.g. pea gravel). Granular size should be 20mm to 150mm with no fine-grained fraction.

The venting trench was advised to be left exposed at ground level to maximise efficiency. The trench was to be located close to the residential gardens, controlled dispersion of gas should be at a chosen location via vent stacks set into the trench. The vent pipes were advised to extend a minimum of 3m in height above ground level with a rotating cowl at the top. The pipe should connect to the pipes extending along the length of the trench to collect the ground gases.

The report then details horizontally laid perforated / slotted pipes in the trench connected to the surface vent pipes. The pipes will act as a preferential path for the gas to migrate to the vent stacks. Collector pipes should be 100mm to 200mm in diameter and the venting pipe should be 3m above ground level.

The width of the trench could be 0.50m to 1.00m and should depend on the ability of the trench to remain stable and the ease of installing the gas membrane. The trench was advised to be placed as close as possible to the new site boundary ensuring stability of land beyond the boundary during excavation and infilling.

If groundwater was encountered during excavation of the new venting trench it may not be possible to reach the natural ground. It was recommended that the work is undertaken during the summer months to ensure the most favourable working conditions.

Ramboll Comments

Ramboll considers that the 2011 trial pitting exercise was rudimentary and did not fully characterise the ground contamination at the site. This was further demonstrated by the 2021 ground investigation which provided good coverage throughout the site, proved depths of Made Ground within the former landfills along with bedrock geology.

Although gas pumping trials have been conducted within the areas of the four former landfills, the ground gas under the proposed development is currently unknown. Ramboll notes a fifth former Landfill is indicated in the third-party environmental database, known as the 'Disused Railway Cutting' and is located adjacent to the Old Field Landfill in the south-east of the site, extending off-site to the south-east along the line of a former railway line. It is not clear if the previous assessments have included this landfill or if it was incorporated into the Old Field for the purpose of their assessments.

Ramboll propose an intrusive investigation that would aim to characterise the ground gas risk to the proposed development, namely underneath the proposed factory and offices. The ground investigation would also aim to identify the underlying thickness of Made Ground (if present) and bedrock geology as well as collected soil and groundwater samples.

10. QUALITATIVE RISK ASSESSMENT

Legislative Framework

The regime for contaminated land was set out in Part 2A (ss.78A-78YC) of the Environmental Protection Act 1990 (EPA), as inserted by S.57 of The Environment Act 1995 and came into effect in England on 1st April 2000 as The Contaminated Land (England) Regulations 2000 (SI 2000/227). These regulations were subsequently revoked with the provision of The Contaminated Land (England) Regulations 2006 (SI 2006/1380) (as amended), which came into force in August 2006,

and consolidated the previous regulations and amendments. Revised statutory guidance (“the Guidance”) for local authorities on how to implement the regime, including the decision-making process on whether land is contaminated land in the legal sense, has been published by Defra and entered into force in April 2012.

Under Part 2A of the EPA Section 78A(2), “contaminated land” is defined as “land which appears... to be in such a condition, by reason of substances in, on or under the land, that:

- a) significant harm is being caused or there is a significant possibility of such harm being caused⁴; or
- b) significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused”.

The pollution of controlled waters is defined in Section 78A(9) of the Act as “the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter”.

Risk Assessment Framework

“Significant harm” or “significant pollution of controlled waters” is defined in the Guidance on risk-based criteria and must be the result of one or more relevant ‘contaminant linkages’ relating to the land.

The presence of a contaminant linkage relies on the Source-Pathway-Receptor concept, where all three factors must be present and potentially or actually linked for a potential risk to exist. For a risk of pollution or environmental harm to occur as a result of ground contamination, all of the following elements must be present:

- A source - a substance that is capable of causing pollution or harm;
- A receptor - something which could be adversely affected by the contaminant; and
- A pathway - a route by which the contaminant can reach the receptor.

If one of these elements is absent there can be no significant risk. If all are present then the magnitude of the risk is a function of the magnitude and mobility of the source, the sensitivity of the receptor and the nature of the migration pathway.

The potential severity of the risk and the probability of the risk occurring have been combined in accordance with the following matrix in order to give a level of risk for each potential hazard.

Classification of Risk (after NHBC/EA 2008)

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very high	High	Moderate	Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/Low	Low	Very low
	Unlikely	Moderate/ Low	Low	Very low	Very low

Preliminary Risk Assessment

A preliminary conceptual site model has been developed and qualitative risk assessment undertaken to identify and assess the potential risks associated with environmental conditions at and in the vicinity of the site based on the available information.

It has been assumed that the site will be redeveloped for continued commercial end use.

⁴ Water Act 2003 (Commencement No. 11) Order 2012

Conceptual Site Model			
Source	Pathway	Receptor	Risk of Contaminant Linkage
Current use of site as derelict land. Five former landfills are present within the site boundary. Stockpiles from demolition of previous site buildings are present in the north-west of the site, along with soil bunds created around the site boundary. Site lies in a "Radon Affected Area", where basic radon protective measures are considered necessary during construction of new buildings for residential use.	Leaching to Groundwater & Groundwater Flow.	Groundwater in the Coal Measures.	Low to Moderate. No significant on-site potential contamination sources from current use; however, composition of soil stockpiles are currently unknown.
	Surface water run-off.	Surface water as controlled water.	Low to Moderate. No significant on-site potential contamination sources from current use; however, it is unknown whether surface water on site is in continuity with a culvert beneath the site which may connect with Dob Sike 110m south-west.
	Dermal contact / ingestion.	Site buildings, users and neighbours.	Moderate. Significant contamination not previously discovered but may be present. Stockpiles and soil bunds are uncovered and potential for ACMs cannot be ruled out. Potential ACM fragments were identified in west of site.
	Vapours / landfill gas.		Moderate to High. Potential for vapours former landfills; areas of landfill are not covered by hardstanding. Proposed office building is located near to former south-eastern landfill. Radon protective measures may be required.
Potential sources of contamination relating to historic use include; Stairfoot Brickworks; Clay Pits which were subsequently landfilled; and Former Railway.	Leaching to Groundwater & Groundwater Flow.	Groundwater in the Coal Measures.	Low to Moderate. Potential contamination from historical activities cannot be ruled out, although previous investigations have shown underlying groundwater is not significantly contaminated.
		Surface water as controlled water via connectivity with groundwater flow.	Moderate. Potential contamination may be present in underlying groundwater and underlying culvert may be affecting Dob Sike 110m south-west.
	Dermal contact / ingestion.	Site buildings, users and neighbours.	Moderate. Potential contamination may be present and may be potential for ACMs in Made Ground and at surface level.
	Vapours / landfill gas.		Moderate to High. Potential for vapours from former Tanks and former landfills; areas of landfill are not covered by hardstanding. Proposed office building is located near to former south-eastern landfill.
Potential current and historical off-site contamination sources in the vicinity of the site include:	Leaching onto site in Groundwater & Groundwater Flow.	Groundwater in the Coal Measures.	Low to Moderate. Potential presence of potential contamination sources from off-site activities including operational PFS.

Clay Pits (extending off-site); Former landfills; Oaks Chemical Plant (with Tanks) located 60m north from 1930s to 1980s; and Tesco branded PFS (70m west).	Vapours / landfill gas.	Site buildings, users and neighbours.	Moderate to High. Potential for vapours from historic use of surroundings. The north of the site has former landfills encroaching onto the site.
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11. SUMMARY AND CONCLUSIONS

Historically, the site was occupied by agricultural fields and a Railway line from the 1850s. By the 1900s Stairfoot Brickworks was present on-site, with associated Clay Pits. The Brickworks and Pits extended until the late 1990s, where the Clay Pits had been infilled or used as former landfills.

The site has had four prominent landfills extending off-site; North Field Phase I and II (to the north-west), South Field (to the north-north-east) and Old Field (to the south-south-west). The Brickworks was demolished by 2016 and the site has remained undeveloped since. *The response from the Environmental Health Department of the Local Authority is still awaited.*

The site is currently not occupied following the demolition of the Brickworks. No activities with the potential to cause significant ground contamination were identified during the site visit. No evidence of bulk storage of fuels or chemicals was identified although some units stored drums of hazardous materials (<1000L).

Potentially contaminative land uses within the surrounding area have included Clay Pits extending from the site to 280m north-west, landfills extending from the site and the Oaks Chemical Plant (with associated Tanks and Gasometers) was present from 60m north-west) the 1930s until the 1980s.

There have been previous ground investigations at the site that have demonstrated limited soil contamination. However, there are ground gas risks and gas and leachate collection systems have been installed on the site. The ground gas risk under the proposed development is unknown, as is the risk to off-site properties.

The site is in a *moderate* sensitive setting with regard to groundwater resources due to the underlying Secondary A aquifer. The site is not located within a Groundwater Source Protection Zone. There are three licensed groundwater abstractions within 2km and none are deemed to be for sensitive use.

The site is in a *low to moderate* sensitive setting with regard to surface water due to Dob Sike 110m south-west. There is one surface water abstraction within 2km and is not deemed to be for sensitive use.

The site lies in a "Radon Affected Area" as defined by Public Health England, with parts of the site being located in an area where between 3% and 5% (north and western area of the site) and 5% and 10% (south and eastern area of the site) of residential properties are projected to contain radon above the residential action threshold).

Basic radon protection measures are considered necessary during the construction of new buildings or extensions in the affected areas (BRE Report BR211, 2015). These guidelines refer to residential dwellings and can be considered conservative for commercial properties. The Action Level for commercial properties is 300 Bq/m³ and assessment of potential worker exposure is the responsibility of the occupant.

On the basis of this environmental site assessment, Ramboll considers that there is a **moderate to high risk** of ground contamination being present at the site. A Phase II investigation is proposed to characterise the soil, groundwater and ground gas risk beneath the proposed development.

Further information has been requested from the regulatory authorities and is awaited.

According to the EA, the site is located in Flood Zone 1 (low probability of fluvial flooding).

12. CONTAMINATED LAND RISK RANKING	Moderate to High
13. REGULATORY FLOOD DESIGNATION	Flood Zone 1 (low probability of fluvial flooding)

This report has been prepared by Ramboll exclusively for the intended use by the client in accordance with the agreement between Ramboll and the client defining, among others, the purpose, the scope and the terms and conditions for the services. No other warranty, expressed or implied, is made as to the professional advice included in this report or in respect of any matters outside the agreed scope of the services or the purpose for which the report and the associated agreed scope were intended or any other services provided by Ramboll.

In preparation of the report and performance of any other services, Ramboll has relied upon publicly available information, information provided by the client and information provided by third parties. Accordingly, the conclusions in this report are valid only to the extent that the information provided to Ramboll was accurate, complete and available to Ramboll within the reporting schedule.

Ramboll's services are not intended as legal advice, nor an exhaustive review of site conditions and/or compliance. This report and accompanying documents are initial and intended solely for the use and benefit of the client for this purpose only and may not be used by or disclosed to, in whole or in part, any other person without the express written consent of Ramboll. Ramboll neither owes nor accepts any duty to any third party, unless formally agreed by Ramboll through that party entering into, at Ramboll's sole discretion, a written reliance agreement.

Unless otherwise stated in this report, the scope of services, assessment and conclusions made assume that the site will continue to be used for its current purpose and end-use without significant changes either on-site or off-site.

Ramboll's scope of services for this assignment did not include collecting samples of any environmental media. Ramboll cannot rule out the existence of conditions, including, but not limited to, contamination not identified and defined by the data and information available to and/or obtained by Ramboll. Specifically, this assessment must not be considered as an asbestos survey (whether in built structures, waste, soils, etc.), even though the subject of asbestos-containing materials may have been discussed in the report.

APPENDIX 1
FIGURES

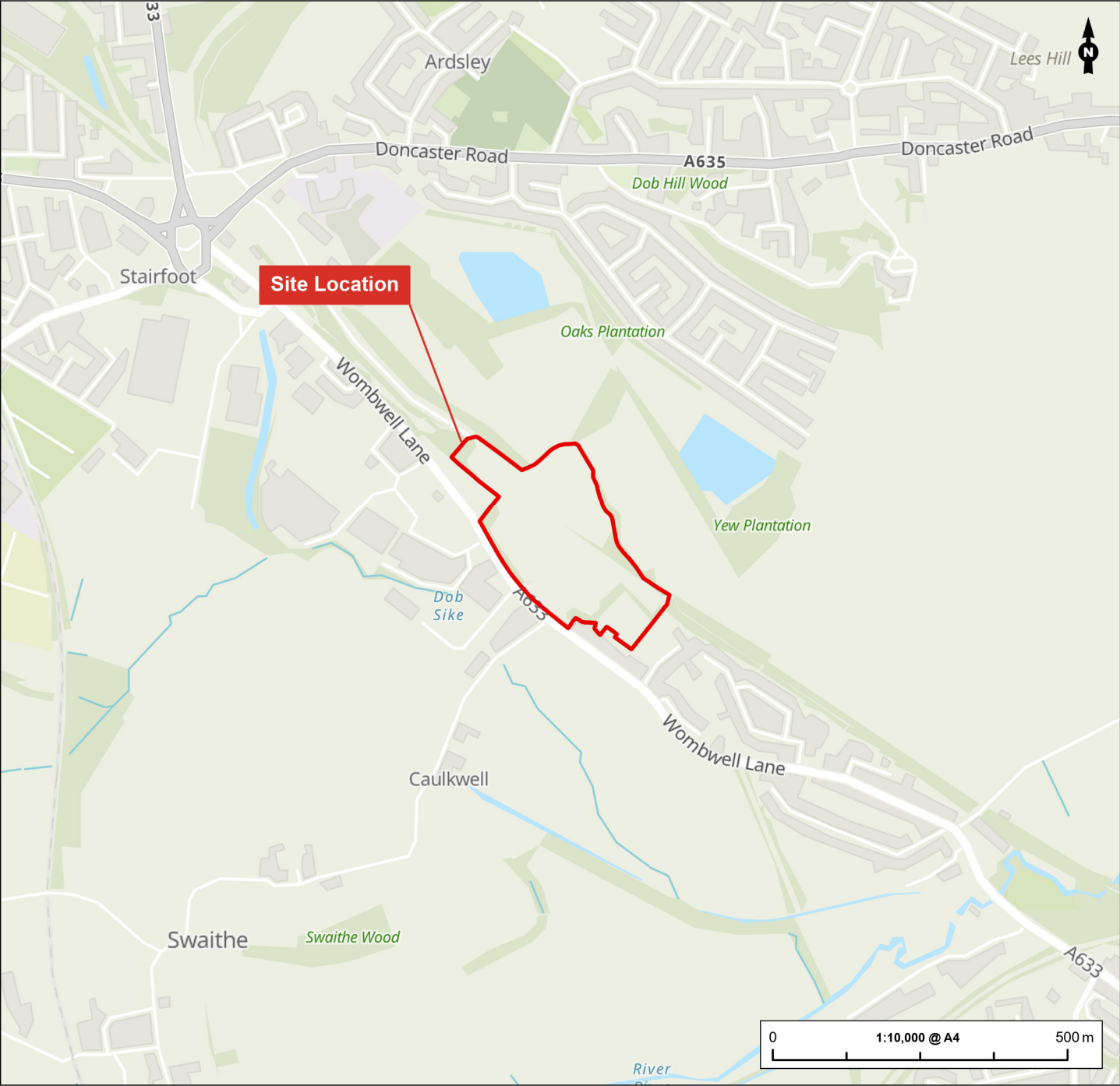


	Figure Title Site Location	Project Name Stairfoot Glassworks	Date March 2024	
	Client Potters Ballotini Limited	Project No./Filery ID 1620015371-002 / REH2023N03396	Prepared By MP	Figure No. 1
			Scale As Shown	Revision 1.0



Legend

 Site Boundary

Figure Title
Site Layout

Project Name
Stairfoot Glassworks

Project No./Filey ID
1620015371-002 / REH2023N03396

Date	Figure No.	Revision
March 2024	2	1.0

Prepared By	Scale
MP	1:2,500 @A4

Client
Potters Ballotini Limited



APPENDIX 2

SELECTED HISTORICAL MAPS



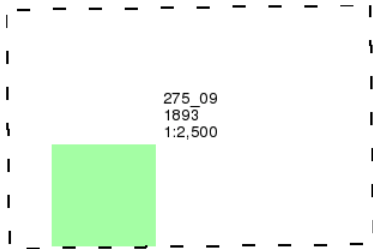
Yorkshire

Published 1893

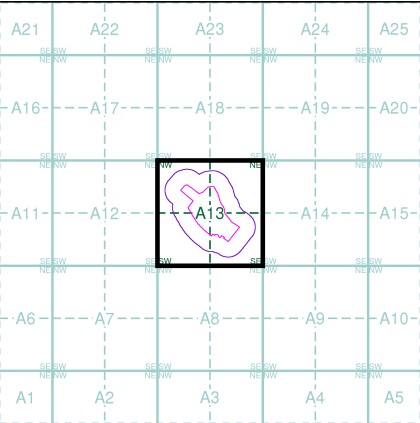
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

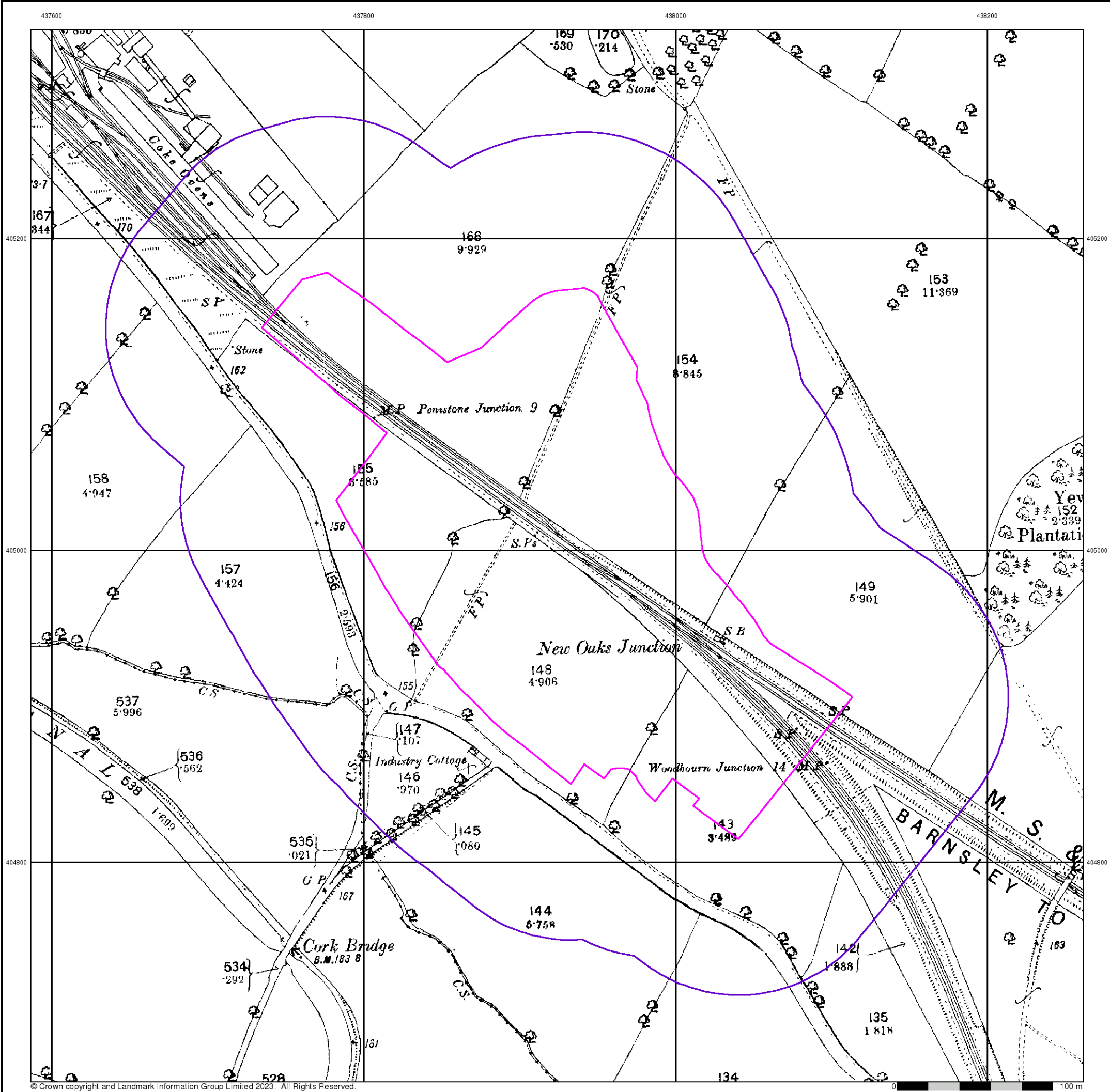
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National Grid Reference: 437920, 405010
Slice: A
Site Area (Ha): 6.47
Search Buffer (m): 100

Site Details

Stairfoot Brickworks, Wombwell Lane, Stairfoot, BARNSELY, S70 3NS



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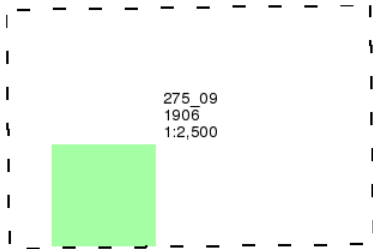
Yorkshire

Published 1906

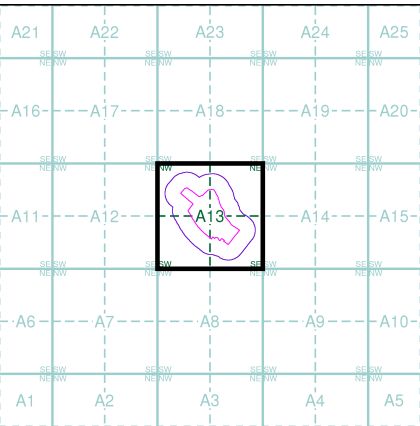
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

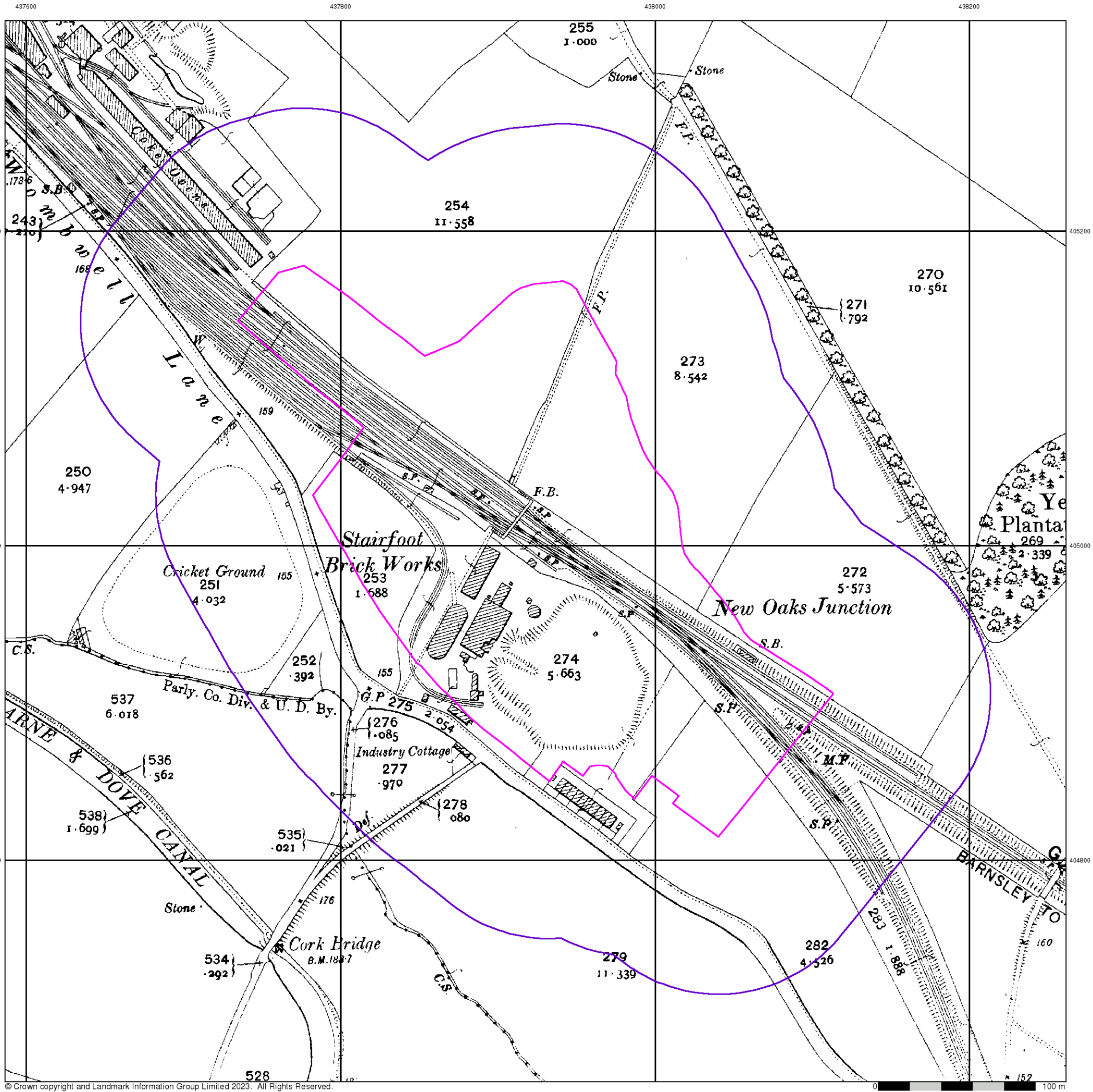
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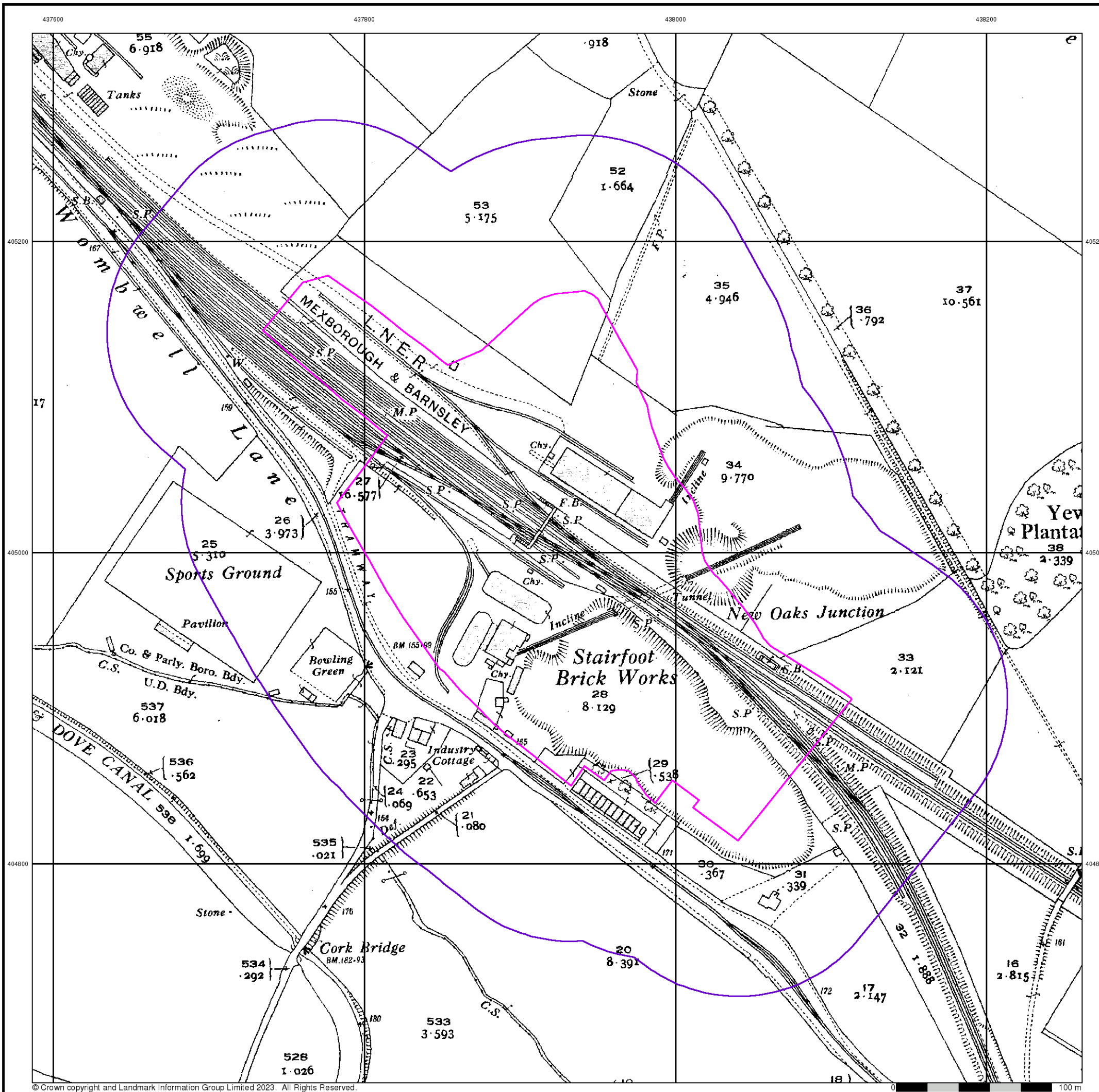
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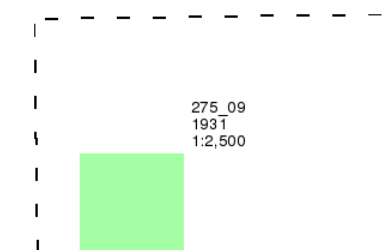
Yorkshire

Published 1931

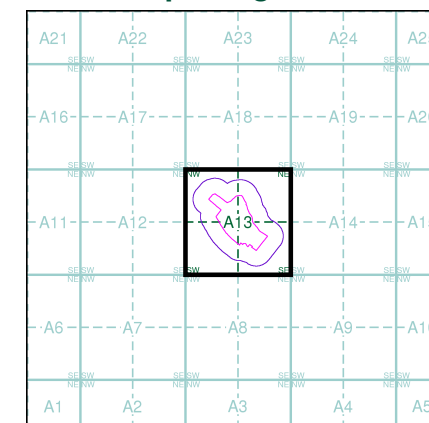
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Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

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Slice: A
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Landmark
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Ordnance Survey Plan

Published 1962

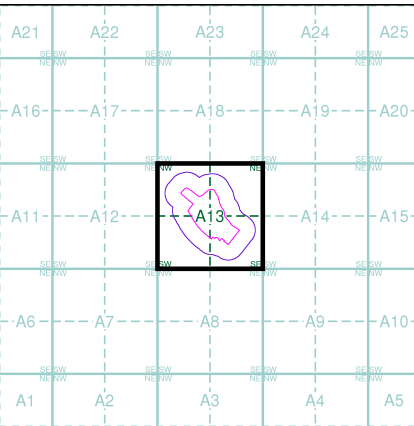
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Map Name(s) and Date(s)

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SE3704 1962 12,500	SE3804 1962 12,500

Historical Map - Segment A13



Order Details

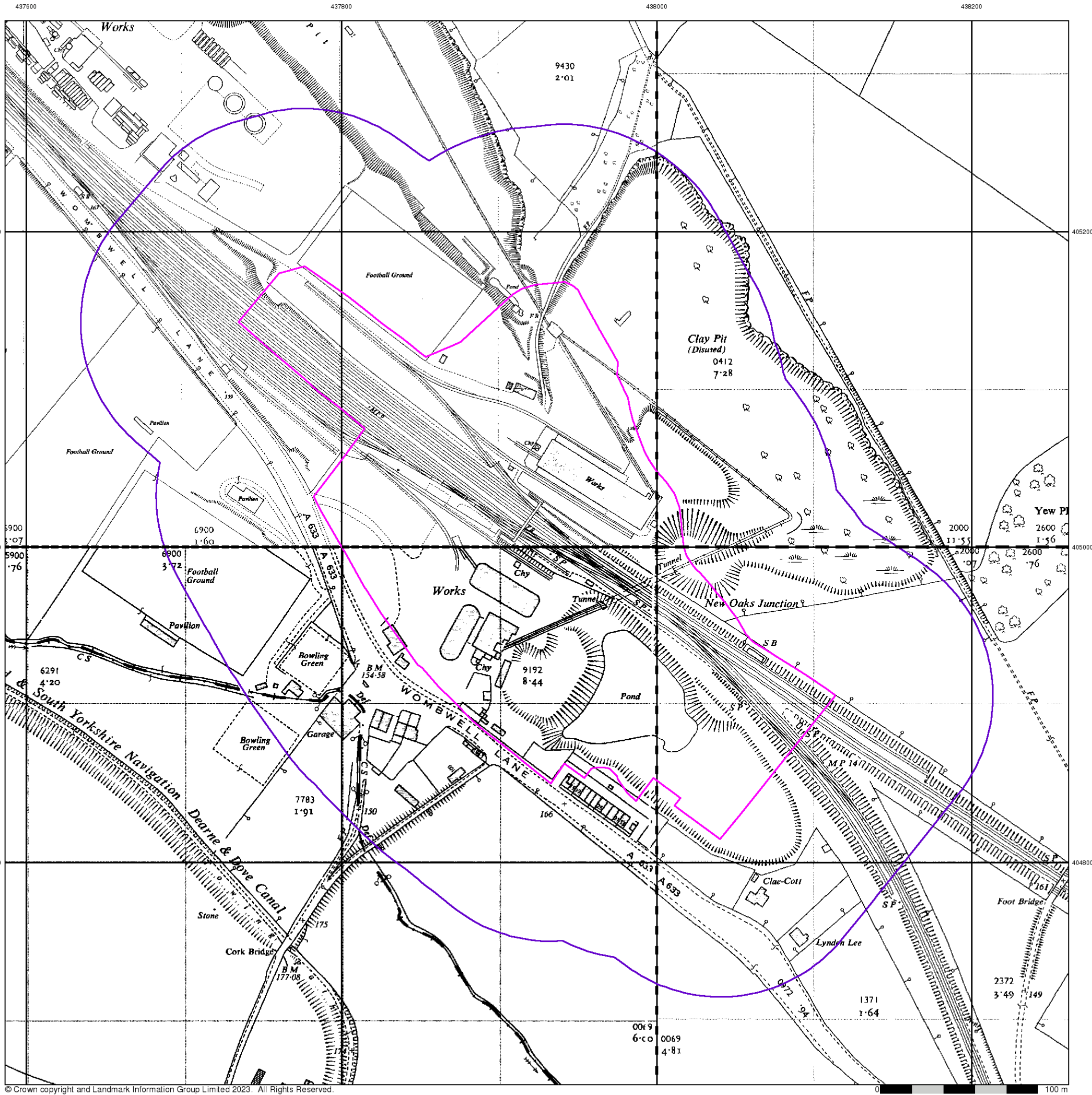
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National Grid Reference: 437920, 405010
Slice: A
Site Area (Ha): 6.47
Search Buffer (m): 100

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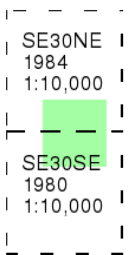
Ordnance Survey Plan

Published 1980 - 1984

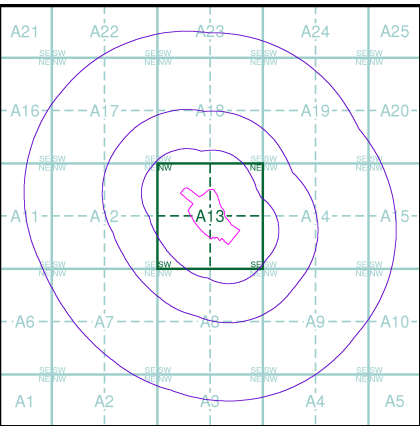
Source map scale - 1:10,000

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number: 316636942_1_1
Customer Ref: 1620057033
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Slice: A
Site Area (Ha): 6.47
Search Buffer (m): 1000

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437600

437800

438000

438200

405200

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404800

404800



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0 100 m

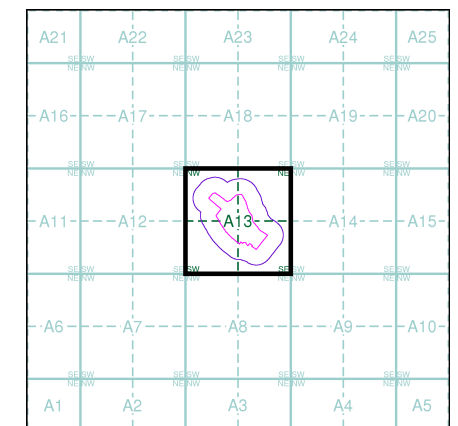


Historical Aerial Photography

Published 1999

This aerial photography was produced by Getmapping, these vertical aerial photographs provide a seamless, full colour survey of the whole of Great Britain

Historical Aerial Photography - Segment A13



Order Details

Order Number: 316636942_1_1
Customer Ref: 1620057033
National Grid Reference: 437920, 405010
Slice: A
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10k Raster Mapping

Published 2006

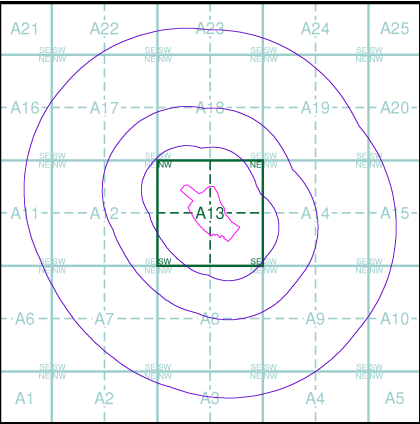
Source map scale - 1:10,000

The historical maps shown were produced from the Ordnance Survey's 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.

Map Name(s) and Date(s)

SE30NE
2006
1:10,000
SE30SE
2006
1:10,000

Historical Map - Slice A



Order Details

Order Number: 316636942_1_1
Customer Ref: 1620057033
National Grid Reference: 437920, 405010
Slice: A
Site Area (Ha): 6.47
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VectorMap Local

Published 2023

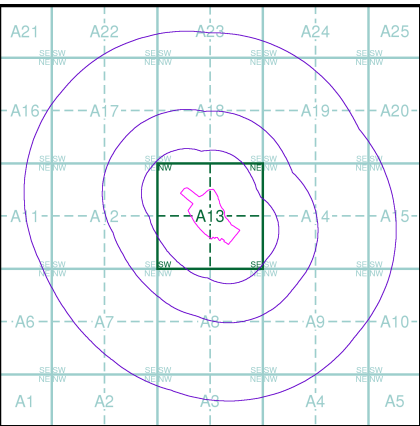
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities), 1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)

SE30NE
2023
Variable
SE30SE
2023
Variable

Historical Map - Slice A



Order Details

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Customer Ref: 1620057033
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