



Geotechnical and Geoenvironmental Report

Site: NPTH Modular Orthopaedic Unit

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Executive Summary

Site Location and Proposed Development	Swansea Bay University Health Board is proposing the development of a Modular Orthopaedic Unit at Neath Port Talbot Hospital. The development site locates between the existing hospital structure to the west and energy centre to the east, within the wider hospital grounds. The site centres on an approximate National Grid Reference of 275440, 190540 occupying a plan area of approximately 0.07 Hectares.
Site History	The site remains undeveloped until the construction of the hospital in c2000. Allotment gardens are recorded at the site from c1978. A refuse tip, declared disused by 1971 located just off site to the southwest.
Geology	The site is shown to be underlain by rock of the South Wales Middle Coal Measures. These are shown to be overlain by Tidal Flat Deposits and Made Ground.
Radon	Radon protective measures are not required for new developments on the investigation site.
Coal Mining Risk Assessment	The overall risk to the surface stability of the site from possible unrecorded workings is considered negligible.
Ground Conditions	Made ground comprising sand and gravel was encountered to a depth of between 5.10-6.50m. Very soft to soft tidal flat silty clay with interbedded fibrous peat overlies dense to very dense sandy gravel at 12.20-13.10m. Bedrock was not encountered.
Contamination of Concern	Sulphate, Asbestos(<0.001%), Methane
Ground Gas Risk Assessment	A potential pollutant linkage has been established. Under the right conditions ground gasses may present a significant risk to identified receptors. To protect the future site users from identified ground gas, proposed structures will need to incorporate within its construction a suitable ground gas protection system.
Foundation Solution	It is recommended a bored/CFA piled foundation solution founded within the very dense gravels at an approximate depth of 12.00 to 15.00m below existing ground level is used. For a 300mm diameter pile with a typical length of 12.00 to 15.00m an allowable working load of 400kN should be achieved.
Recommended Further Works	Remediation Strategy & Ground Gas Protection System Verification Plan Validation of the Remediation Strategy and Ground Gas Protection System

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Drawing 01 Site Layout

SECTION 1 Introduction and Proposed Development

1.1 Introduction

Swansea Bay University Health Board (the Client) is proposing the development of a Modular Orthopaedic Unit at Neath Port Talbot Hospital.

TFW Group Limited hereon referred to as Terra Firma have been commissioned by RVW Consulting, the project engineer, on behalf of the Client to undertake a geoenvironmental assessment and geotechnical investigation of the site.

The main objectives of the geoenvironmental assessment programme are:

- Investigate the potential human health and environmental liabilities at the site associated with any contamination
- Provide a summary of the human health and environmental conditions at the site, together with any necessary further intrusive works and / or remediation works to render the site fit for its intended use

The main objectives of the geotechnical site investigation are:

- Investigated the type, strength and bearing characteristics of the shallow superficial and underlying solid geology
- Investigate the risk, if any, from historical shallow underground mining features
- Provide engineering foundation and floor slab recommendations for the proposed development
- Provide infiltration rates and stormwater drainage viability.
- Provide recommendations regarding any other geotechnical aspects pertaining to the development

In order to achieve the above objectives, Terra Firma carried out an assessment programme including a site walkover, a review of existing data, followed by a field investigation to collect geotechnical and geoenvironmental data from selected locations.

1.2 Limitations and Exceptions of Investigation

The Client has requested that a Geoenvironmental Site Assessment (GSA) and Geotechnical Investigation (GI) be performed to enable the outlined main objectives.

The GSA and GI were conducted, and this report has been prepared for the sole internal reliance of the Client and their design and construction team. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Terra Firma. If an unauthorised third party comes into possession of this report, they rely on it at their peril and the authors owe them no duty of care and skill. The report represents the findings and opinions of experienced geoenvironmental and geotechnical consultants. Terra Firma does not provide legal advice and the advice of lawyers may be required.

The subsurface geological profiles, any contamination and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested.

1.3 Quality Assurance

The quality and environmental aspects of the assessment comply with Terra Firma business management system which is UKAS Accredited to ISO 9001:2015 and ISO 14001:2015 standards.

SECTION 2 Review of Existing Data

2.1 Physical Setting and Current Site Use

The development site is rectangular in shape and locates between the existing hospital structure to the west and energy centre to the east, within the wider hospital grounds. The site centres on an approximate National Grid Reference of 275440, 190540 occupying a plan area of approximately 0.07 Hectares.

The investigation area comprises open undeveloped land, with footpaths crossing to the northeast and southeast, areas of grass and gravel and a small concrete slab positioned centrally within the area.

The site elevation is approximately 7m AOD and relatively level.

The site location can be seen on **Figure 2.1** along with the site layout on **Drawing 01**.

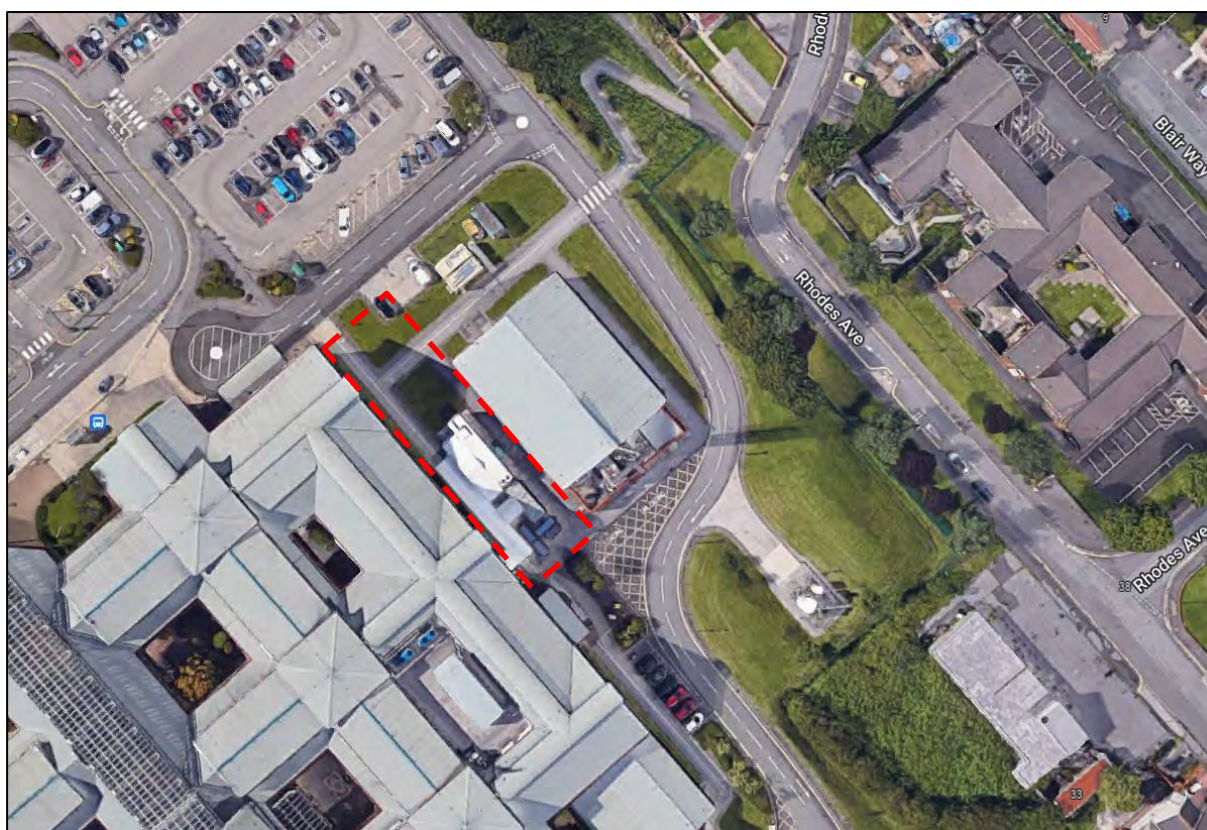


Figure 2.1 Site Location (Google Satellite Imagery)

2.2 Site History

Historical maps of the site have been obtained in an Envirocheck Report, provided by Landmark Information Group. The history plans are supplied in **Annex A** of this report, and the most relevant editions are summarised in **Table 2.1**. Distances, where quoted are approximate, and any changes in-between map editions may not be recorded

Table 2.1 Historical Development from Map Information

Map Edition & Scale	Key Features on Site	Key Features off Site
1876/1877 (1:2,500)	The site is shown to comprise undeveloped	Land is generally undeveloped in the immediate vicinity. Drainage reens cross the area.

	land located in Aberavon Moor.	A railway line runs 330m NE and 'sand' siding runs 330m SE of the site.
1884 (1:10,560)	The site remains unchanged.	The surrounding area remains unchanged.
1899 (1:2,500)	The site remains unchanged.	The Rhondda & Swansea Bay Railway has been constructed 350m SW. Sand siding is recorded as disused. Terrace housing, known as Sandfields has developed to within 460m SE.
1900 (1:10,560)	The site remains unchanged.	The surrounding area remains unchanged.
1917/1918 (1:2,500)	The site remains unchanged.	Further urban development has occurred in Sandfields, 380m SE of the site.
1921 (1:10,560)	The site remains unchanged.	The surrounding area remains unchanged.
1936/1939 (1:2,500)	The site remains unchanged.	Further urban development has occurred in Sandfields, 320m S of the site.
1949 (Aerial)	The Aerial Photo shows the site to comprise undeveloped land	The site is immediately surrounded by fields.
1951/1952 (1:10,560)	The site remains unchanged.	An allotment garden is indicated 90m SE. A refuse heap is located 120m SW
1971/1972 (1: 1,250 & 1:2,500)	The site remains unchanged.	A refuse tip indicated 140m WSW. to 60M W. Urban expansion has occurred 380m SW and SE. Tip recorded as disused by 1971.
1974 (1:10,000)	The site remains unchanged.	The surrounding area remains unchanged.
1978/1989 (1:1,250)	The far south of the site is included within allotment gardens.	Residential housing locates 110m SE and a Hostel locates 70m NE
1991/1993 (1:1,250)	The site remains unchanged.	Commercial/Industrial Units locate 220m NW
1995 (1:10,000)	Allotments no longer recorded at the site.	The surrounding area remains unchanged.
2000 Aerial Photo	The photo shows earthworks underway at the site.	-
2006 (1:10,000)	The site is shown to locate in the NE of a Hospital Development	The site is surrounded by Neath Port Talbot Hospital
2021 (1:10,000)	The site remains unchanged.	The site is surrounded by Neath Port Talbot Hospital

2.3 Anecdotal Information

It is understood that by the 1970's the Tip known to have located to the southwest extended onto the site.

2.4 Geological Setting

2.4.1 Geology

The 1:50,000 scale BGS geological map of the area (Sheet 247 Swansea) was consulted for geology underlying the site. The site is shown to be underlain by rock of the South Wales Middle Coal Measures. These are shown to be overlain by Tidal Flat Deposits and Made Ground. Detailed stratigraphical information is provided in **Table 2.2**.

Table 2.2 Detailed Stratigraphical Information

Period	Formation
Quaternary	Tidal Flat Deposits – Sand, silt and clay
Carboniferous	South Wales Middle Coal Measures – Grey productive coal bearing mudstone, siltstone with seatearths and minor sandstones

Made ground is anticipated at the site.

2.4.2 BGS Borehole Information

The site may have been reprofiled since boreholes were performed.

BGS Borehole SS79SE396 locates within the study site at an elevation of 7.19m AOD. The borehole was performed in 1999 and encountered 3.80m of Made Ground, including slag, over firm, very silty clay. Water rose to 2.80m BGL.

BGS Borehole SS79SE397 locates south of the study site. The borehole was performed in 1999 and was commenced at 6.56m AOD. The borehole encountered 4.20m of Made Ground, including slag, over sandy, very silty clay with occasional gravel and lenses of peat. At 11.4m depth below ground level very dense sandy slightly silty gravel was encountered.

2.4.3 Radon

The Envirocheck Report (**Annex A**) details that no radon protective measures are required for new developments on the investigation site.

2.4.4 Mining

A Coal Authority CON29M Report was obtained for the site. The report revealed that the site is not in a surface area that could be affected by recorded underground coal mining. The Coal Authority Report is presented in **Annex B**.

There are no BGS mineral sites as recorded within 500m of the study site.

2.4.5 Natural Hazards

The underlying geology is not prone to dissolution and the risk of natural cavities in the bedrock is considered negligible.

Shallow superficial soils have the potential for compressible ground, sensitive clays and running sand conditions.

Peat is anticipated at depth beneath the site.

2.5 Environmental Setting

The following sections have been compiled using the Landmark Information Group Envirocheck datasheet and maps which can be found in **Annex A**.

2.5.1 Hydrogeology

Superficial deposits beneath the site have an aquifer designation of secondary aquifer – Undifferentiated.

The bedrock deposits beneath the site have an aquifer designation of secondary aquifer – A.

Deeper groundwater flow within the underlying bedrock will be controlled by the strata dip and any fractures or bedding planes within the rock units. Groundwater may be tidally influenced.

The site does not locate within a groundwater source protection zone.

There are no groundwater abstractions within 500m of the site.

2.5.2 Hydrology

The nearest surface water feature locates off site 114m south and comprises a pond.

2.5.3 Flooding

The Agency and Hydrological Map in the Envirocheck Report does not show the site to be affected by Zone 2 or Zone 3 flooding from Rivers or Sea. However, BGS flooding susceptibility records indicate there is potential for groundwater flooding to occur at surface.

2.5.4 Waste

Recorded landfill sites within 250m of the site are summaries in **Table 2.3**.

Table 2.3 Landfill Sites Summary

Landfill Name	Distance/ Direction from site	Operation Dates	Deposited Wastes
Baglan Landfill	125m S	Unknown	Unknown

The Hospital Site is recorded as a Licensed Waste Management Facility (Clinical Waste Transfer Station)

The Hospital is registered for the disposal of Radioactive Waste.

There are no discharge consents within 500m of the site

2.5.5 Pollution

No pollution incidents are recorded to have occurred within 500m radius of the site.

2.5.6 Sensitive Land Use

The site is not located within a sensitive land use area.

2.5.7 Estimated Urban Soil Chemistry

The BGS have published estimated urban soil chemistry concentrations locally to the site for a number of common contaminants, i.e. arsenic, cadmium, chromium, lead and nickel. All of

the given determinants have anticipated concentrations that are below the recognised trigger levels for a residential with plant uptake scenario.

2.5.8 Industrial Land Use

One relevant contemporary trade directory entry is recorded in proximity of the site which relates to the broader hospital site. This is summarised in **Table 2.4**.

Table 2.4 Relevant Contemporary Trade Summary

Company	Distance/Direction from site	Classification	Status
Neath General Hospital	69m	Hospitals	Active

SECTION 3 Coal Mining Risk Assessment

3.1 Geotechnical Risk

3.1.1 Underground Mining

Based upon geological map data, the stratigraphical sequence within ~30m of the ground surface of the site is illustrated in **Figure 3.1**.

Made Ground		3.00-5.00m
Superficial Deposits	Tidal Flat Deposits – Very soft silty CLAY with layers of PEAT	11.50m
	Fluvioglacial Deposits – Very dense sandy GRAVEL	>20.00m
South Wales Middle Coal Measures	Mudstone, Siltstone	

Figure 3.1 Geology and Strata Base below Ground Level

The Coal Authority Report has not identified any coal mining related features that will impact on the stability of the proposed development.

Geological map and BGS borehole evidence corroborates with the findings of the Coal Authority Report.

3.1.2 Shafts & Adits

The Coal Authority Report states there are no known mine entries within 20m of the site.

3.1.3 Conclusion

The overall risk to the surface stability of the site from possible unrecorded workings is considered negligible.

3.2 Geoenvironmental Risk

3.2.1 Mine Gas Risk Assessment

The overall risk to future site users from potential mine gas is considered negligible.

SECTION 4 Preliminary Human Health and Environmental Risk Assessment

4.1 General

The preliminary human health and environmental risk assessment is a qualitative evaluation of unacceptable risks to human health or the environment from potential 'contaminated land', based on reviewed information in preceding sections of this report.

For 'contaminated land' to exist as defined in Part 2A of the Environmental Protection Act (EPA) 1990, a Pollutant Linkage needs to be identified. Pollutant linkages are defined by having a valid 'source – pathway – receptor' as established in the preliminary conceptual site model.

For our definitions of pollution linkage and how we define risk please refer to **Annex C** which includes our classifications of consequence and probability, and risk assessment matrix.

4.2 Potential Sources of Contamination

Potential or known sources of contamination associated the sites current and historical land use are summarised in **Table 4.1**.

Table 4.1 Contamination Sources

ID	Source	Contaminant
S1	Made ground (up to 4-5m thick)	Metals, metalloids, phenols, sulphates, asbestos, PAH, hydrocarbons; Ground gasses – Carbon dioxide, Methane
S2	Refuse Tip (off site 125m S, anecdotally on-site)	Landfill gasses – Carbon dioxide, Methane

No other significant potential on-site or off-site sources of contamination have been identified during the desk study.

4.2.1 Omitted Potential Sources

Potential sources of contamination highlighted in this study have been excluded from further risk assessment. Sources and omission reasoning are listed in **Table 4.2**.

Table 4.2 Omitted Contamination Sources

Source	Reasoning
Mine Gas	No deep workings or shafts recorded within proximity of the site. Shallow groundwater anticipated. Groundwater would inhibit mass flow of gas from any potential deep mine gas source which if present would also be flooded by this time.
Peat (ground gasses)	Peat is not considered a significant source of ground gas. Organic materials that were once deposits within a fluvial environment, submerged below layers of fine clays have long since decomposed. Therefore its gas generation potential is nil, the gas within it is finite. Any gasses still trapped within this strata are locked within the pore space of the soil confined due to the high permeability of the alluvial clays they are within, only diffusing into the surrounding soils over a geological period. The potential for lateral migration of any remaining gasses is negligible. Furthermore these soils are likely to be fully saturated. For there to be a risk there needs to be an opportunity for a large volume of gas to be released over a short period of time, Peat deposits do not permit this scenario. (Ground Gas Handbook by Steve Wilson, Geoff Card & Sarah Haines 2009)

4.3 Potential Pollution Pathways

Potential contaminant pathways associated with a commercial land use are as follows.

- P1 – Direct soil and dust ingestion
- ~~P2 – Consumption of home-grown produce~~
- P3 – Dermal contact
- P4 – Inhalation of dust and vapours
- P5 – Vertical migration of leachates (unsaturated zone)
- P6 – Horizontal and vertical migration of contaminants (saturated zone)
- P7 – Artificial contaminant pathway (borehole, pile, excavation etc)
- P8 – Surface run-off
- ~~P9 – Plant uptake~~
- P10 – Horizontal and vertical migration of ground gasses and vapours
- P11 – Direct contact with construction materials
- P12 – Inhalation of asbestos fibres

4.4 Potential Receptors

There are human and hydrological receptors to any contamination that may be present on site. Potential receptors include.

- R1 – Construction and maintenance workers
- R2 – Future site users (staff and visitors)
- R3 – Passers-by or neighbouring site users
- R4 – Groundwater (aquifer)
- R5 – Surface waters (pond/reen)
- R6 – Area of public open space
- R7 – Construction materials (concrete/potable water pipes)

4.5 Preliminary Conceptual Site Model

The preliminary conceptual site model establishes potential pollutant linkages between contaminants (source), pathways and receptors, realised during the preparation of the desk study report. Where a potential pollutant linkage is identified an assessment of risk is subsequently undertaken. The preliminary conceptual site model is tabulated in **Table 4.3**.

Outcomes of the preliminary conceptual site model are used as a basis for the design and implementation of the site investigation, whereby areas of potential contamination can be targeted as well as investigating the wider site.

Findings of the site investigation can in turn be used to develop and refine the conceptual site model.

Table 4.3 Preliminary Conceptual Site Model

Source	Pathway	Receptor	Preliminary Risk Assessment		
			Consequence	Probability	Risk
Human Health					
Contaminated Soils S1	Direct soil and dust ingestion P1 Dermal contact P3 Inhalation of dust and vapours P4 Inhalation of asbestos fibres P12	Construction and maintenance workers R1	Medium	Low Likelihood	Low Risk – COSHH assessment and good level of PPE/ hygiene by site workers/ staff; dust suppression measures if required. Details of which should be documented in the contractors method statements.
		Passers-by or neighbouring site users R3	Medium	Low Likelihood	Low Risk – Easily mitigated against, dust suppression measures to be adopted if required. Details of which should be documented in the contractors method statements.
		Future site users R2	Medium	Unlikely	Low Risk – Future site users whether these be hospital staff or patients are unlikely to come into contact with site soils. Furthermore, the proposed structure is anticipated to cover the whole study area, essentially capping off any possible pathway.
Landfill Gas S2	Horizontal and vertical migration of ground gasses and vapours P10	Construction and maintenance workers R1 Future site users R2	Severe	Likely	High Risk – historical landfill site within influencing distance, suitable gas investigation essential
Ground Gas S1			Severe	Unlikely	Low Risk – the presence of thick made ground presents a low risk to receptors
Impacted Groundwaters S1	Horizontal and vertical migration of contaminants (saturated zone) P6 Dermal contact P3	Construction and maintenance workers R1	Medium	Unlikely	Low Risk – contact with groundwaters easily mitigated against and should be documented in the contractors method statements
Contaminated Soils S1	Direct Contact P11	Construction materials (water pipes) R7	Mild	Low Likelihood	Low Risk – soil testing recommended to establish the extent of any risk
Aggressive ground conditions – Sulphates S1		Construction materials (concrete) R7			
Aquatic Environment					

Contaminated Soils S1	Vertical migration of leachates (unsaturated zone) P5 Artificial contaminant pathway (borehole, pile, excavation etc) P7	Groundwater (aquifer) R4	Mild	Low Likelihood	Low Risk – non-sensitive water resource
	Surface run-off P8 Vertical migration of leachates (unsaturated zone) P5 Horizontal and vertical migration of contaminants (saturated zone) P6	Surface waters (pond/reen) R5	Mild	Low Likelihood	Low Risk – significant distance to potential receptors. Pathways exasperated by construction methods easily mitigated against. Details of which should be documented in the contractors method statements.

SECTION 5 Field Investigation

5.1 Site Works

A geotechnical and geoenvironmental site investigation comprising three deep boreholes, one soakaway, three shallow boreholes, concrete coring and four hand excavated trial pits was undertaken between the 14th March and 5th April 2022.

The fieldwork was supervised by Terra Firma, who logged the exploratory holes to the requirements of BS 5930:2015+A1:2020. The proposed locations of the exploratory holes were determined by the Client's engineer.

The ground levels and coordinates at each exploratory hole were established by Terra Firma using GPS techniques.

Trial pit referenced TP03 was formed using a tracked excavator with a 0.60m wide bucket.

Trial pits referenced TP01-TP02 and TT01-TT02, were hand excavated to uncover the thickness of the concrete slab and depth of concrete duct respectively.

On completion all trial pits were backfilled with materials arisings compacted in layers using the excavator bucket or hand tool.

The trial pit logs are presented in **Annex D**.

A soakaway test was carried out in trial pit TP03 in general accordance with BRE DG 365:2016. The excavation sides were squared using the excavator bucket and dimensions recorded within the test section. The trial pit was partially filled with clean water using a dedicated bowser with a 75mm diameter outlet and the fall in level recorded against time. The results are presented in **Annex E**.

The boreholes referenced WS01 to WS03, were formed using a Terrier 2000 rig. Dynamic sampling techniques were employed from surface to produce a continuous disturbed sample. Concrete coring of the surface was undertaken at WS02 and CC01 using the rig coring attachment and a 150mm diameter bit.

Standard penetration tests (SPT) were carried out at regular intervals in general accordance with BS1377: Part 9:1990:3.3. SPT results summarised as N values are presented on the borehole log.

Boreholes were monitored for groundwater ingress as drilling proceeded.

Representative disturbed samples were taken and retained in airtight containers for environmental testing.

On completion, boreholes were installed with slotted standpipes consisting of a 50mm ID HDPE slotted tube set in a granular filter zone and sealed above with a bentonite plug. Installations were protected at surface with a flush cover. Full installation details are recorded on the relevant logs.

The shallow borehole logs are presented in **Annex F**.

Boreholes reference BH01 to BH03 were formed using a light cable tool (shell and auger) drilling rig. Boreholes were advanced from surface using 200mm tools and casing with the occasional use of a heavy chisel to assist boring.

Standard penetration tests (SPT) were carried out at regular intervals in general accordance with BS1377: Part 9:1990:3.3. SPT results summarised as N values are presented on the borehole log.

Representative disturbed samples were taken and retained in airtight containers for geotechnical testing.

Boreholes were monitored for groundwater ingress as drilling proceeded.

On completion BH01 to BH03 were backfilled with materials arising and the surface reinstated.

The deep borehole logs are presented in **Annex G**.

Exploratory hole locations are shown on **Drawing 01**.

5.2 Ground Conditions

The ground conditions encountered by the exploratory holes can in general be summarised as shown in **Table 5.1**.

Table 5.1 Summary of Typical Ground Conditions

Depth (m)			Thickness (m)	Stratum
0.00	-	5.10/6.50	5.10-6.50	MADE GROUND comprising medium dense to very dense gravelly SAND or sandy GRAVEL of slag, with rare plastic, glass and ceramic fragments, and cobbles.
5.10/6.50	-	8.00/9.50	2.90-3.40	Very soft to soft brownish grey silty CLAY .
8.00/9.50	-	9.20/11.00	1.20-1.60	Soft dark brown fibrous PEAT .
9.20/11.00		12.20/13.10	1.30-3.00	Very soft grey silty CLAY .
12.20/13.10		15.00/15.20	-	Dense to very dense sandy GRAVEL with low to medium cobble content.

5.3 Buried Utilities Duct

Trial trenches were undertaken at two locations perpendicular to a buried utilities duct, indicated on **Drawing 01**. Typically the concrete duct was encountered at a depth of between 0.11-0.17m below ground level with an approximate width of 3.50m. Coordinates taken of the corner edge in each of the trial trenches are summarised in **Table 5.2**.

Table 5.2 Trial Trench Coordinates

Description	Easting	Northing	Level (m)
Trial Trench 1 (TT01) south-eastern edge	275454.138	190526.670	7.76
Trial Trench 1 (TT01) north-western edge	275451.956	190529.401	7.76
Trial Trench 2 (TT02) south-eastern edge	275446.264	190520.119	7.79
Trial Trench 2 (TT02) north-western edge	275443.690	190522.130	7.79

5.4 Groundwater

Groundwater was not encountered during the investigation.

Water was added to assist advancement of boreholes BH01 to BH03.

5.5 Stability and Obstructions

Deep boreholes refused in very dense ground conditions between 15.00-15.20m.

Shallow borehole WS03 refused in very dense conditions at 1.40m.

Trial pits remained stable and vertical during excavation.

5.6 Installation Well Construction

Gas well locations were selected on a non-targeted basis to characterise the gas contamination status of the investigation area. A regular distributed pattern was adopted.

Gas installation well construction details are summarised in **Table 5.3**.

Table 5.3 Installation Well Summary

Location	Response Zone		Stratum
	From (m)	To (m)	
WS01	0.80	3.00	Made Ground
WS02	1.00	3.00	
WS03	0.40	1.40	

5.7 Laboratory Chemical Testing

5.7.1 Sampling Strategy

Soil sampling locations were selected on a non-targeted basis to characterise the contamination status of the investigation area. A regular distributed sampling pattern was adopted.

Sample locations, depths and suspected/known contamination source targets are summarised in **Table 5.4**:

Table 5.4 Sample Locations, Depths and Targets

Location	Depth (m)	Contamination Targets
WS01	0.8	S1 – Made Ground
WS02	1.00	
WS03	0.5	
BH01	0.3-1.20	
BH02	1.20-1.65	
BH03	0.30-1.00	

5.7.2 Soil Laboratory Analysis

During the site investigation works soil samples were taken and despatched to the accredited laboratories of Eurofins Chemtest for laboratory chemical testing. Soil samples were tested for the determinants listed in **Table 5.5**.

Table 5.5 Soil Laboratory Analysis

Metals & Metalloids	In-Organics	Organics	Others
Arsenic	Cyanide	Phenols	pH (acidity)
Cadmium	Sulphate	PAH	Asbestos
Chromium III		Petroleum Hydrocarbons	
Chromium VI		CWG	

Copper			
Lead			
Mercury			
Nickel			
Selenium			
Zinc			

The results are discussed in detail in **SECTION 6** and the laboratory test results certificates may be found in **Annex H**.

5.8 Soil Property Testing

5.8.1 In-situ Permeability Testing

During the site investigation one trial pit soakaway test was undertaken in TP03 and carried out in general accordance with BRE DG 365:2016.

Soakaway test results are summarised in **Table 5.6**.

Table 5.6 Summary of Soakaway Results

Trial Pit	Depth Range of Test (m)	Infiltration Rate (ms ⁻¹)
TP03	1.00-1.47	3.52x10 ⁻⁰⁵

The test results are discussed in **SECTION 10.6** and the calculation sheets may be found in **Annex E**.

5.8.2 Laboratory Geotechnical Testing

A schedule of laboratory tests was prepared by Terra Firma Wales Ltd and samples were despatched to the accredited laboratories of GSTL. A summary of the testing carried out is presented in **Table 5.7**.

Table 5.7 Summary of Geotechnical Testing

Geotechnical Test	Standard (BS1377:1990)	No. Tested
Moisture Content	Part 2, Clause 3.2	6
PSD Wet Sieve Method	Part 2, Clause 9.2	2
PSD Sedimentation by Pipette	Part 2, Clause 9.4	1
Dry Den/MC (2.5kg Rammer Method 1 Litre Mould)	Part 4, Clause 4.3	3
BRE SD1	-	4

The soil classification test results are presented in **Annex H & I** and discussed in **SECTION 7** of this report.

SECTION 6 Evaluation of Geoenvironmental Analytical Results

6.1 Assessment Methodology

A Tier 1 assessment of the analytical results has been made with comparison to the 2015 Suitable 4 Use Levels (S4UL) provided by Land Quality Management (LQM) Limited and the Chartered Institute of Environmental Health (CIEH) or Category 4 Screening Levels (C4SL) provided by the Department for Environment, Food and Rural Affairs (DEFRA, 2014). In lieu of S4UL or C4SL generic assessment criteria, comparison is made to published Soil Guideline Values (SGV) by the Environment Agency 2009.

Sulphate results have been compared to guidelines presented in British Research Establishment (BRE SD1:2015). Sulphate levels need only be considered for buried concrete risk assessment and are not human health related.

6.2 Soil Test Results

A summary of the chemical test results which include the regulatory soil guideline values used in a commercial setting are given in the following tables. The complete results can be found in **Annex H**.

6.2.1 Inorganics

Six samples were tested for a standard suite of inorganics, pH and organic matter. The summarised results are in **Table 6.1**.

Table 6.1 Summary of Soil Chemical Test Results – Inorganics

Substance	Threshold Value (mg/kg)	Source	Measured Concentrations (mg/kg)		Number of Exceedances
			Minimum	Maximum	
Arsenic	640	LQM/CIEH	7.9	14	0
Cadmium	190	LQM/CIEH	<0.1	0.16	0
Chromium III	8600	LQM/CIEH	8.7	39	0
Chromium VI	33	LQM/CIEH	<0.5	<0.5	0
Copper	68000	LQM/CIEH	17	27	0
Lead	2300	pC4SL	12	87	0
Mercury (inorganic)	1100	LQM/CIEH	<0.05	0.08	0
Nickel	980	LQM/CIEH	7.1	39	0
Selenium	12000	LQM/CIEH	<0.2	0.4	0
Zinc	730000	LQM/CIEH	52	100	0
Cyanide	-	-	<0.5	<0.5	-
Boron	240000	LQM/CIEH	0.92	6.8	0
Sulphate (%)	0.24	BRE	0.12	0.8	6
Organic Matter (%)	-	-	0.8	2.4	-
pH	-	-	8.6	10.3	-
Notes:					
- No available guideline					

6.2.2 Organics

Six samples were tested for speciated polycyclic aromatic hydrocarbons. The summarised results are in **Table 6.2**.

Table 6.2 Summary of Soil Chemical Test Results – Speciated Polycyclic Aromatic Hydrocarbons

Substance	Threshold Value (mg/kg)	Source	Measured Concentrations (mg/kg)		Number of Exceedances
			Minimum	Maximum	
Naphthalene	190	LQM/CIEH	<0.1	0.18	0
Acenaphthylene	83000	LQM/CIEH	<0.1	0.11	0
Acenaphthene	84000	LQM/CIEH	<0.1	0.63	0
Fluorene	63000	LQM/CIEH	<0.1	0.73	0
Phenanthrene	22000	LQM/CIEH	<0.1	3.4	0
Anthracene	520000	LQM/CIEH	<0.1	1.2	0
Fluoranthene	23000	LQM/CIEH	<0.1	3.9	0
Pyrene	54000	LQM/CIEH	<0.1	3.4	0
Benzo(a)anthracene	170	LQM/CIEH	<0.1	2.4	0
Chrysene	350	LQM/CIEH	<0.1	3.1	0
Benzo(b)fluoranthene	44	LQM/CIEH	<0.1	2.8	0
Benzo(k)fluoranthene	1200	LQM/CIEH	<0.1	1.1	0
Benzo(a)pyrene	35	LQM/CIEH	<0.1	2.1	0
Indeno(123cd)pyrene	500	LQM/CIEH	<0.1	1.3	0
Dibenzo(ah)anthracene	3.5	LQM/CIEH	<0.1	0.65	0
Benzo(ghi)perylene	3900	LQM/CIEH	<0.1	1.3	0
Total PAH	-	-	<2.0	28	-

Notes:

Thresholds based on 1.0% soil organic matter

- No available guidelines

Six samples were tested for petroleum hydrocarbon. The summarised results are shown in **Table 6.3**.

Table 6.3 Summary of Soil Chemical Test Results – Petroleum Hydrocarbons

Substance	Threshold Value (mg/kg)	Source	Measured Concentrations (mg/kg)		Number of Exceedances
			Minimum	Maximum	
Aliphatic					
PH C5 – C6 Ali	3200	LQM/CIEH	<1.0	<1.0	0
PH C6 – C8 Ali	7800	LQM/CIEH	<1.0	<1.0	0
PH C8 – C10 Ali	2000	LQM/CIEH	<1.0	<1.0	0
PH C10 – C12 Ali	9700	LQM/CIEH	<1.0	<1.0	0
PH C12 – C16 Ali	59000	LQM/CIEH	<1.0	<1.0	0
PH C16 – C21 Ali	1600000*	LQM/CIEH	<1.0	<1.0	0
PH C21 – C35 Ali	1600000*	LQM/CIEH	<1.0	<1.0	0
PH C35 – C44 Ali	1600000	LQM/CIEH	<1.0	<1.0	0
Aromatic					
PH C5 – C7 Arom	26000	LQM/CIEH	<1.0	<1.0	0
PH C7 – C8 Arom	56000	LQM/CIEH	<1.0	<1.0	0
PH C8 – C10 Arom	3500	LQM/CIEH	<1.0	<1.0	0
PH C10 – C12 Arom	16000	LQM/CIEH	<1.0	<1.0	0
PH C12 – C16 Arom	36000	LQM/CIEH	<1.0	<1.0	0
PH C16 – C21 Arom	28000	LQM/CIEH	<1.0	<1.0	0

PH C21 – C35 Arom	28000	LQM/CIEH	<1.0	<1.0	0
PH C35 – C44 Arom	28000	LQM/CIEH	<1.0	<1.0	0

Notes:

PH – Petroleum Hydrocarbon

Ali – Aliphatic

Arom – Aromatic

Thresholds based on 1.0% soil organic matter

* – Ali C16-21 and C21-C35 based on criteria for Ali EC >16-35

Six samples were tested for Phenols. The summarised results are in **Table 6.4**.

Table 6.4 Summary of Soil Chemical Test Results – Phenols

Substance	Threshold Value (mg/kg)	Source	Measured Concentrations (mg/kg)		Number of Exceedances
			Minimum	Maximum	
Phenols	440	LQM/CIEH	<0.10	<0.10	0

6.2.3 Asbestos Testing

All made ground soil samples were scheduled for asbestos screening. Asbestos was detected in 1no. sample. Samples testing positive for asbestos were further scheduled for gravimetric quantification of ACM. The results are summarised in **Table 6.5**.

Table 6.5 Summary of Soil Chemical Test Results – Asbestos Quantification

Sample	Depth (m)	Comment	Result (mass %)
BH03	0.3-1.0	Fibres/clumps Chrysotile	<0.001

SECTION 7 Geotechnical Testing Results

Geotechnical testing results are summarised in the following sections and presented in their entirety in **Annex I**.

7.1 Particle Size Distribution Analysis

Two samples were subject to particle size distribution (PSD) testing. The results are summarised in **Table 7.1**.

Table 7.1 Summary of Particle Size Distribution Testing

Location	Depth (m)	Clay (%)	Silt (%)	Sand (%)	Gravel (%)	Cobbles/ Boulders (%)
BH01	1.20-1.65	14		25	61	0
BH03	1.2-1.65	11	8	35	46	0

7.2 Moisture Content Testing

During the investigation six samples were taken and submitted for moisture content testing. The test results are summarised in **Table 7.2**.

Table 7.2 Moisture Content Test Results

Location	Depth (m)	Moisture Content (%)
BH03	6.5-6.95	40
BH01	1.2-1.65	25
BH01	9.5-9.95	33
BH02	3.0-3.45	41

7.3 Compaction Testing

Three samples were subject to compaction testing using a 2.5kg rammer. The results are summarised in **Table 7.3**.

Table 7.3 Compaction Testing Summary

Location	Depth (m)	Initial Moisture Content (%)	Maximum Dry Density (Mg/m ³)	Optimum Moisture Content (%)
BH01	1.2-1.65	14	2.05	12
BH02	1.2-1.65	16	2.08	10
BH03	1.0-1.20	20	1.92	10

7.4 BRE SD1 Testing

Four samples were subject to BRE SD1 testing for concrete classification. The results are summarised in **Table 7.4**.

Table 7.4 BRE SD1 Testing Summary

Location	Depth (m)	2:1 Water/Soil Extract		Total Potential Sulphate (%)	pH	Design Sulphate Class for Location	ACEC Class for Location
		SO ₄ (mg/l)	Mg (mg/l)				
BH03	2.50	360		0.29	9.5	DS-2	AC-2
BH01	6.5-6.95	340		0.39	9.6	DS-2	AC-2
BH02	3-3.45	460		0.12	8.6	DS-1	AC-1
WS01	0.8	160		0.15	9.6	DS-1	AC-1

SECTION 8 Ground Gas Risk Assessment

8.1 Gas Risk Characterisation

8.1.1 Gas Source

Made ground was encountered with a thickness of between 5.10-6.50m and typically contained waste anthropogenic materials. However, the most significant potential gas source remains to be the off site landfill.

8.1.2 Gas Migration Pathways

Made ground soils were observed to be granular in composition. Moisture content of shallow soils suggests a high saturation. Subsequent monitoring visits have revealed water in boreholes between 2.40-2.50m below ground level.

8.1.3 Potential Receptors

Future site user including all staff, patients and visitors are considered potential receptors. Groundworks undertaken below ground level in confined space may present a risk to construction and maintenance workers.

8.2 Gas Screening Value

Three ground gas monitoring wells were installed in boreholes WS01 to WS03. Installation details are shown on the relevant log.

Two rounds of gas monitoring have been carried out to date. The installations were tested for carbon dioxide, methane, oxygen, carbon monoxide and hydrogen sulphide using a Gas Analyser GA5000.

Recorded gas concentrations are summarised in **Table 8.1**.

Table 8.1 Measured Gas Concentration Summary

Gas	Minimum (% V/V)	Maximum (% V/V)
Methane	0.2	10.5
Carbon Dioxide	0	0.5
Oxygen	17.3	21.5

The gas flow rate from the boreholes was also assessed, a maximum typical flow rate of 0.3l/hr was recorded.

Based on a flow rate of 0.3l/hr and the highest recorded methane concentration of 10.5%, a gas screening value of 0.0315l/hr is calculated, as follows:

$$(10.5/100) \times 0.3 = 0.0315\text{l/hr}$$

The results to date are presented in **Annex J**.

8.3 Conclusion

When this monitoring result is compared with Table 8.5 of CIRIA report C665, the site is classified as 'Gas Characteristic Situation 1' (CS1). However, as the peak methane has significantly risen above 1%, it is recommended that 'Gas Characteristic Situation 2' (GS2) is applied to the site in line with recommendations provided in CIRIA C665.

Upon completion of the full six rounds of monitoring the recommendation will be reviewed in a letter report and if necessary amended.

A potential pollutant linkage has therefore been established. Under the right conditions ground gasses may present a significant risk to identified receptors.

SECTION 9 Quantitative Risk Assessment

9.1 Contaminants of Concern

Contaminants identified as part of the investigation are summarised in **Table 9.1**, along with an interpretation of the likely contamination source. Where applicable, the contaminant, source relationship is based on the inferences made in the preliminary conceptual site model.

Table 9.1 Contaminants of Concern

Location	Depth	Contaminant	Source
BH03	0.3-1.0	Sulphate, Asbestos(<0.001%)	S1
BH03	2.5	Sulphate	
BH01	6.5-6.95	Sulphate	
BH02	1.2-1.65	Sulphate	
WS03	0.5	Sulphate	
WS02	1.0	Sulphate	
WS02	1-3.00	Methane	S1, S2

9.2 Pollutant Linkages

Based on the findings of the intrusive site investigation and identified contaminants, the preliminary conceptual site model has been revised. Significant pollutant linkages are tabulated in the refined conceptual site model **Table 9.2**. Identified pollutant linkages will require detailed risk assessment, appropriate mitigation or remedial measures.

Table 9.2 Refined Conceptual Site Model

Source	Pathway	Receptor
Contaminated Soils S1	Direct soil and dust ingestion P1 Dermal contact P3 Inhalation of dust and vapours P4 Inhalation of asbestos fibres P12	Construction and maintenance workers R1 Passers-by or neighbouring site users R3 Future site users R2
Landfill Gas S2 Ground Gas S1	Horizontal and vertical migration of ground gasses and vapours P10	Construction and maintenance workers R1 Future site users R2
Aggressive ground conditions – Sulphates S1	Direct Contact P11	Construction materials (concrete) R7

9.3 Mitigation and Remedial Measures

The following sections summarise the likely mitigation and remedial measures suitable for the identified contamination and proposed development. Detailed methodology to achieve the measures should be prescribed in a Remediation Strategy Report and the results presented in a Validation Report upon completion of the development.

9.3.1 Human Health

9.3.1.1 Contaminated Soils

It is evident from laboratory testing that asbestos is present in made ground soils. Subsequent gravimetric testing has however demonstrated this risk to be very low. Suitable mitigation with regards to this risk should be dealt with in contractor method statements, taking into account the safety and well being of construction workers and adjacent site users.

The advice from an asbestos specialist should be sought to help develop suitable precautions to protect receptors, suitable protection measures may include:

- Dust suppression and measures to dampen the material

- Suitable PPE for site workers
- Air monitoring on the site boundary
- Personal air monitors (for a time to determine actual personnel / fibre interaction)

In addition to the above it is best practise to clean down plant and change air filters on any plant used in the works with asbestos contaminated material.

To protect future site users from the identified asbestos in near surface soils, it is recommended that a proportionate capping system is adopted. It is however understood that the building will cap the entire investigation area eliminating the need for any further mitigation. In the event soft landscaped areas are included within the final design, it is considered a capping layer of 300mm of inert topsoil or hardstanding with subbase will suffice given it is unlikely that gardening activities will be undertaken at the site.

Consistently sulphate levels were recorded at elevated levels in made ground. To protect from aggressive ground conditions substructure concrete should be specified accordingly.

As good practice, construction workers should adhere to good site management, COSHH, good standards of hygiene and appropriate health & safety on site, with personal protection equipment (PPE) and dust suppression where appropriate.

All imported soils should be validated as clean and suitable for use in accordance with 'Requirements for the Chemical Testing of Imported Soils for Various End Uses and Validation Cover Systems'.

In accordance with EC Regulation 1272/2008 and Environment Agency Guidance WM3 soils destined for off-site disposal should be classified on the basis of their hazard phrases prior to disposal. Soils are classified as a mirror entry waste and should be classified on the basis of their specific chemical properties.

If during earthworks ground conditions are encountered that are markedly different to those found during the investigation then the ground should be subject to additional sampling and testing and any necessary remedial measures designed and implemented before continuing with the works.

9.3.1.2 Ground Gas

To protect the future site users from identified ground gas, proposed structures will need to incorporate within its construction a suitable ground gas protection system. The ground gas protection system should be designed, verified, installed and validated in accordance with the British Standard 8485:2015+A1:2019 and CIRIA guidance C735:2014.

It is recommended that a specialist consultant is retained to prepare a risk assessed ground gas protection system Verification Plan for the proposed development. The Verification Plan will detail the required protection measures based on the perceived risk associated with the complexity of design, experience of the installer, size of the site and gas characteristic situation. The Verification Plan also details the step by step process and requirements to allow for the completion of a Validation Report. Terra Firma are specialists in this area of expertise.

Validation of installed ground gas protection systems by an independent third party will be required upon completion of the development. Validation may only be achieved if processes prescribed in the Verification Plan are undertaken.

9.3.2 Aquatic Environment

Site specific mitigation and remedial measures are not required with respect to the aquatic environment.

During the construction period, there is a risk to the environment/adjacent sites from de-watering, digging foundations, moving contaminated soil, drainage misconnections, discharges to local surface waters or the ground, runoff from construction materials and/or exposed ground, wheel washings and oil or chemical spills.

The risk is considered to be negligible as any adverse effects will be easily preventable by due diligence to good construction practise and housekeeping in preventing surface runoff and the spillage of materials.

The basic measures that should be taken are as follows:

- Prepare a drainage plan and mark the manholes to prevent pollutants accidentally reaching the surface water sewers;
- Carry out any activities that could cause pollution in a designated, bunded area, away from rivers or boreholes. Where possible it should drain to the foul sewer;
- Use settlement ponds to remove silty water;
- Store all oils and chemicals in a fully bunded area to prevent leaks or spills;
- Get advice on whether you need an environmental permit and apply in good time

SECTION 10 Engineering Recommendations

10.1 Preparation of Site

Areas of vegetation including all roots should be stripped and removed from beneath the proposed development site.

Allowances should be made for any temporary/permanent support works to any existing adjacent structure necessary as a result of the proposed works.

Contingencies should be made for the protection/diversion of any underground/overhead services present beneath/above the site brought about as a result of the proposed works.

Any reduced levels should be brought up to the required levels with suitable inert mainly granular materials. Department of Transport (DTp) type 2 sub-base or similar should be used and compacted in layers to the requirements of the Specification for Highway Works.

Allowances should also be made for the excavation of any soft spots/areas and their replacement with well compacted imported granular materials.

In accordance with EC Regulation 1272/2008 and Environment Agency Guidance WM3 soils and other materials destined for off-site disposal should be classified on the basis of their hazard phrases prior to disposal. Soils are classified as a mirror entry waste and should be classified on the basis of their specific chemical properties. Terra Firma (Wales) Ltd offer this service if required.

10.2 Foundation Solution

It is recommended a bored/CFA piled foundation solution founded within the very dense gravels at an approximate depth of 12.00 to 15.00m below existing ground level is used. For a 300mm diameter pile with a typical length of 12.00 to 15.00m an allowable working load of 400kN should be achieved. Variations in the given pile lengths should also be expected. Due to the very dense nature of the upper made ground allowances should be made for pre-boring a high percentage of piles.

Measurements should be put in place to monitor vibrations during pile installation. If vibrations exceed guideline levels, then measures should also be taken to dampen such vibrations. If, however, vibrations exceed permissible values then consideration should be given to an alternative solution.

The estimated working pile loads, pile type and lengths are given for guidance only and should be confirmed by a specialist piling contractor and it may be prudent to test drive/install piles at selected locations.

For the quoted pile sizes, founded within the competent in-situ materials, total settlements should not exceed 10mm with differential movements between adjacent piles being less than half this value.

Allowances should be made for the removal of any 'soft spots' and their replacement with well-compacted granular materials. Department of Transport (DoT) Type 2 materials or similar could be used and should be compacted in layers to the specification for Highway Works.

Floor slabs should be designed as suspended.

All foundation formations should be inspected by a suitably qualified Engineer before being concreted.

10.3 Excavations and Formations

Most of the shallow excavations will be possible with normal soil excavating machinery.

Shallow perched water and groundwater flows were not encountered during the investigation. Any water inflows together with rainwater infiltration should be dealt with by conventional pumping techniques. However, it should be noted that during times of heavy rainfall a higher water table will be encountered.

The sides of any excavations deeper than 1.20m, or shallower if unstable, should be supported by planking and strutting or other proprietary means.

The sub-formations/formations are likely to be susceptible to loosening, softening and deterioration by exposure to weather (rain, frost and drying conditions), the action of water (flood water or removal of groundwater) and site traffic.

Formations should never be left unprotected and continuously exposed to rain causing degradation, or left exposed/uncovered overnight, unless permitted by a qualified engineer.

Construction plant and other vehicular traffic should not be operated on unprotected formations.

As a minimum the formation/excavation surfaces must be protected by blinding concrete immediately after exposure.

Allowances should be made for the removal of soft spots/areas and their replacement with well compacted granular materials.

Allowances should also be made for special precautions to prevent formation deterioration in addition to the above.

10.4 Protection of Buried Concrete

When the results are compared with Table C2 of BRE Digest 1:2005, it indicates that buried concrete should generally conform to Class AC-2.

10.5 Access Roads and Car Parking Areas

For car parking and road areas, formations within the in-situ natural soils a CBR value of 5% may be used for design purposes.

Allowances should be made for the removal of any 'soft spots/areas' and their replacement with well-compacted granular materials as previously described.

Please note that the Local Council / Highways Authority may require in-situ CBR testing to be undertaken before a road is adopted. In-situ CBR Testing should be performed following earthworks to verify the performance of the engineered fill.

10.6 Storm Water Drainage

During the site investigation one soakaway test was undertaken in general accordance with BRE DG 365:2016. The soakaway test was carried out in trial pit TP03 within natural materials.

The soakaway tests recorded an infiltration rate of between $3.52 \times 10^{-5} \text{ ms}^{-1}$. The use of soakaway stormwater drainage is therefore considered viable at the location and depths tested.

Proposed soakaways should be positioned at least 5.0m away from any structure.

10.7 Reuse of Site Won Material

Three samples of shallow made ground materials were subjected to dry density and moisture content relationship testing.

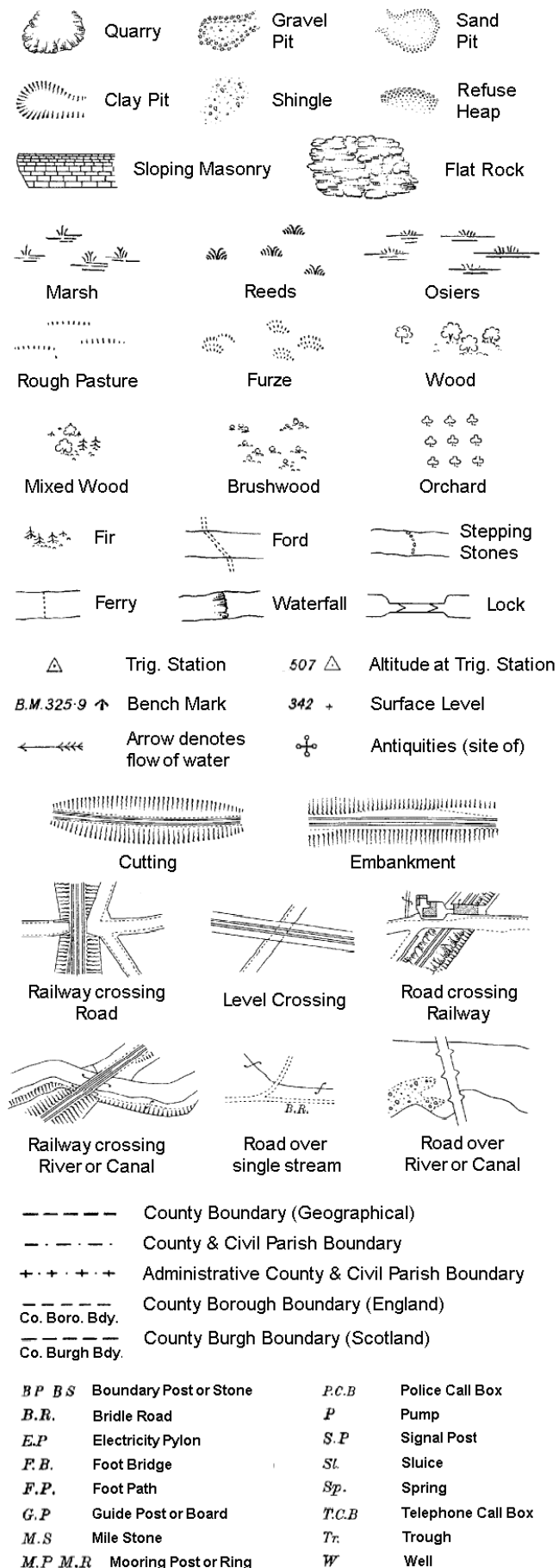
The dry density moisture content relationship result for the shallow made ground materials indicated soils would require significant drying prior to reuse. An initial average moisture content of 17% and an optimum moisture content of 11% was recorded. The average maximum dry density recorded was 2.02Mg/m³.

With reference to the Specification for Highway Works Series 600 Earthworks, the near surface made ground soils are most likely to be classified as 6F1 selected granular fill typically used for capping. Reference should be made to Table 6/4 'Method 6' of the same publication for guidance on suitable compaction plant, layer thicknesses and number of passes.

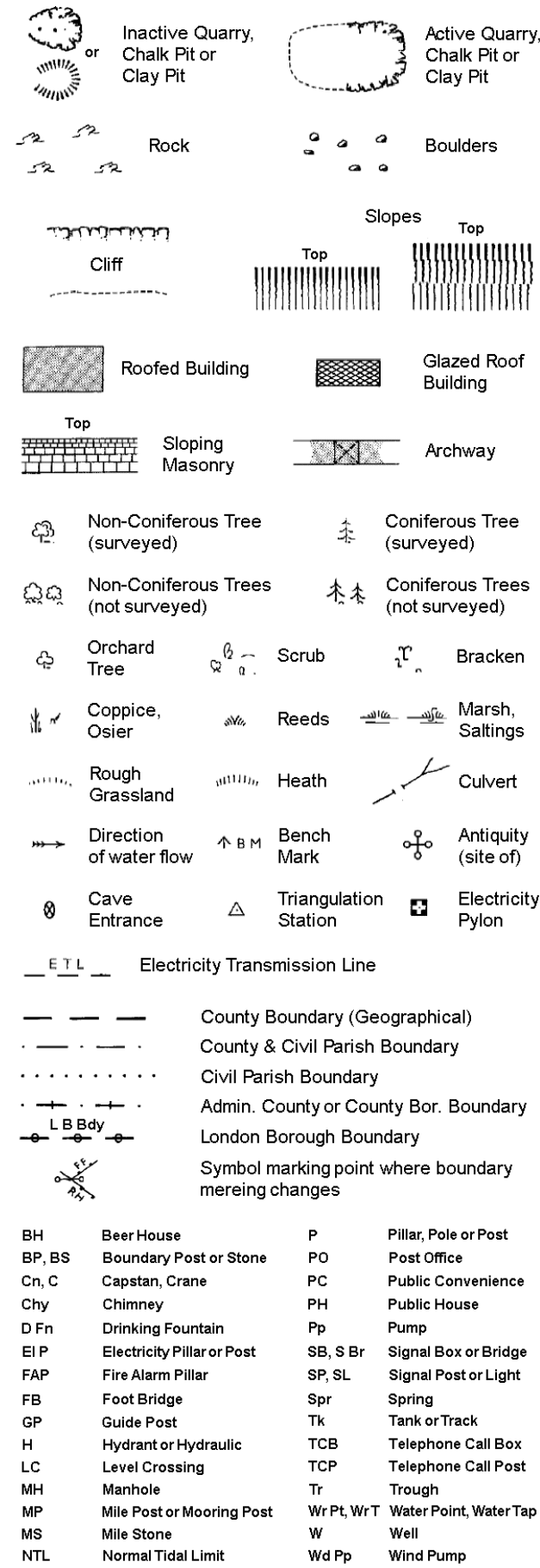
ANNEX A
Envirocheck Report

Historical Mapping Legends

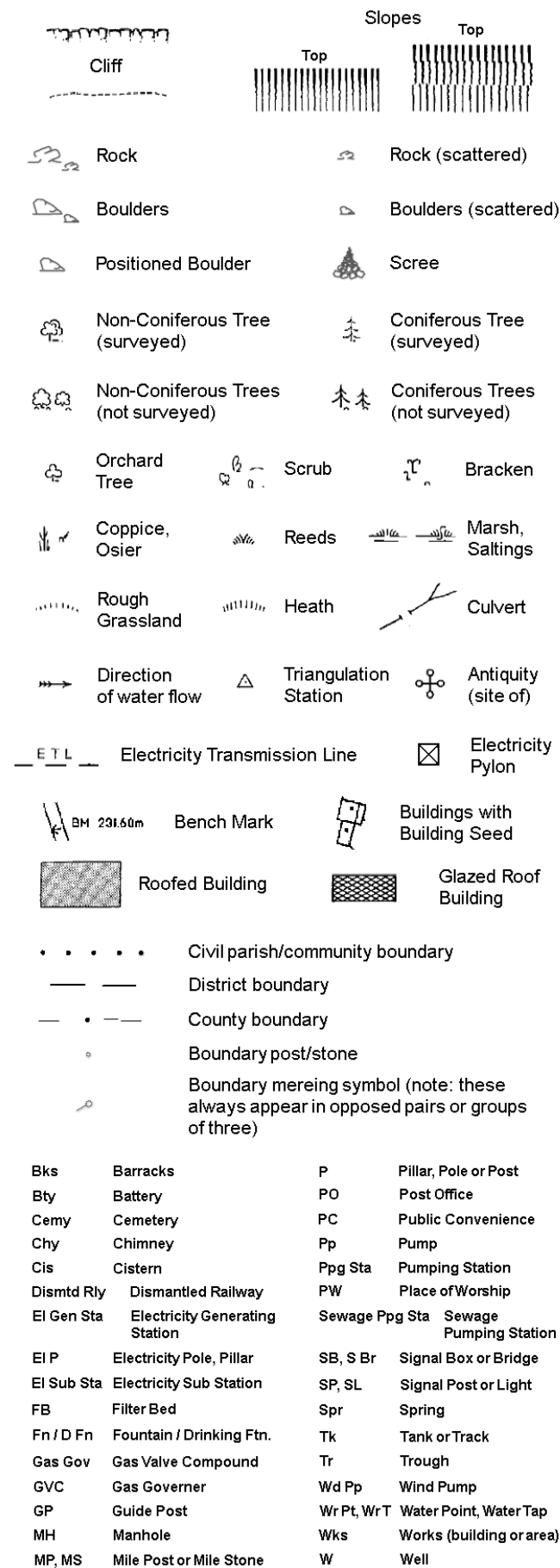
Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250



Large-Scale National Grid Data 1:2,500 and 1:1,250

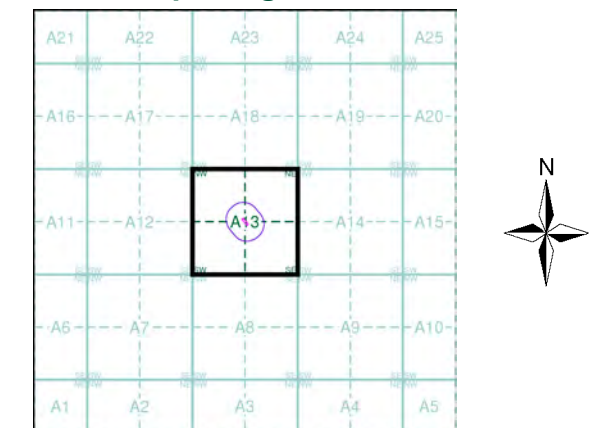


Geotechnical & Geoenvironmental Specialists

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Glamorganshire	1:2,500	1876	2
Glamorganshire	1:2,500	1899	3
Glamorganshire	1:2,500	1917 - 1918	4
Glamorganshire	1:2,500	1936 - 1939	5
Ordnance Survey Plan	1:1,250	1952 - 1971	6
Ordnance Survey Plan	1:2,500	1958	7
Ordnance Survey Plan	1:1,250	1963 - 1964	8
Ordnance Survey Plan	1:1,250	1967	9
Ordnance Survey Plan	1:1,250	1972	10
Additional SIMs	1:1,250	1978 - 1989	11
Additional SIMs	1:1,250	1987 - 1991	12
Additional SIMs	1:1,250	1991	13
Large-Scale National Grid Data	1:1,250	1993	14
Large-Scale National Grid Data	1:1,250	1995	15
Large-Scale National Grid Data	1:1,250	1996	16
Historical Aerial Photography	1:2,500	2000	17

Historical Map - Segment A13



Order Details

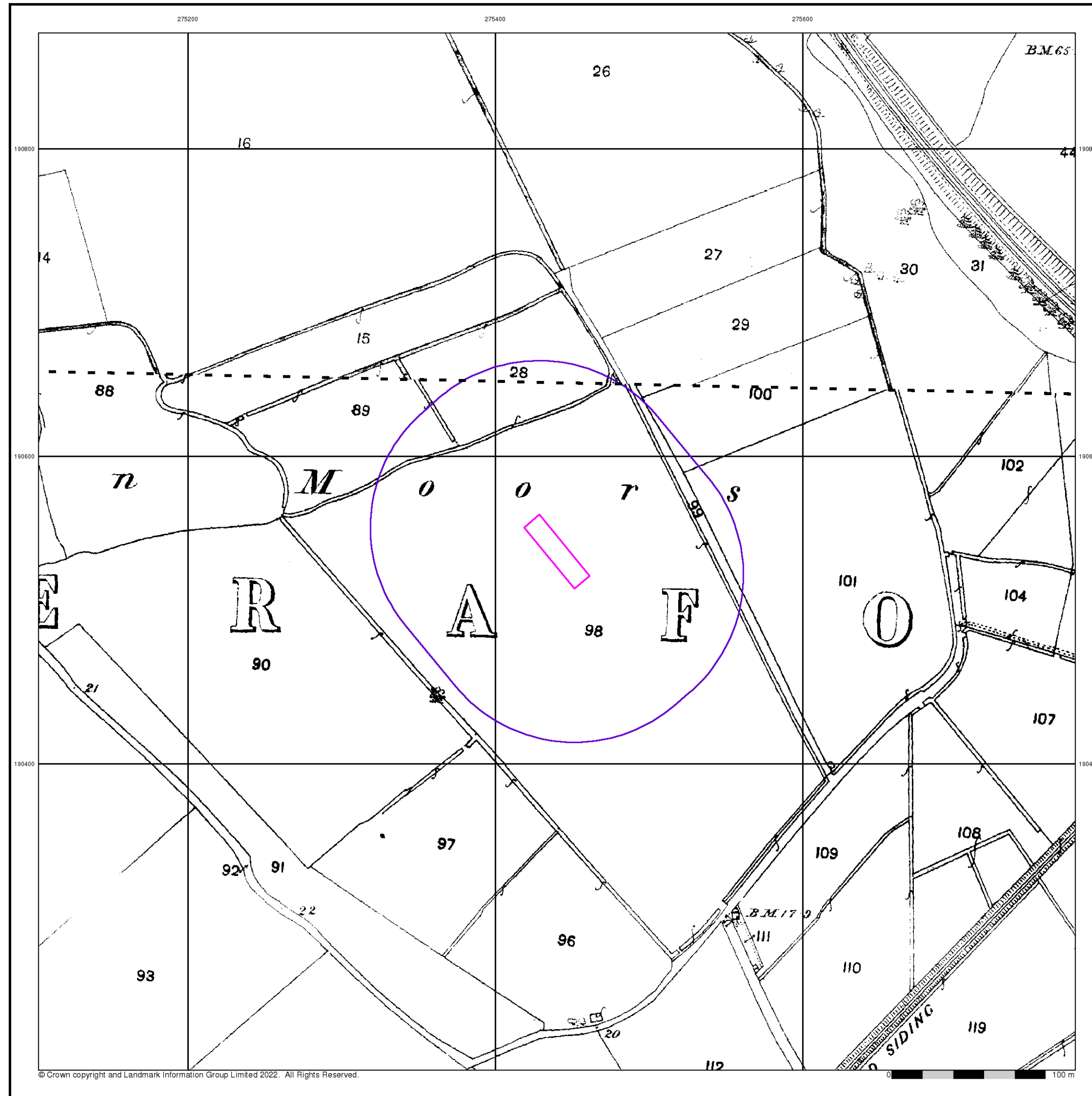
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

Site at 275450, 190530



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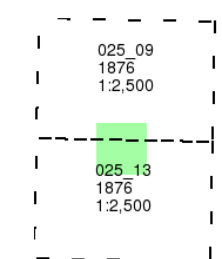
Glamorganshire

Published 1876

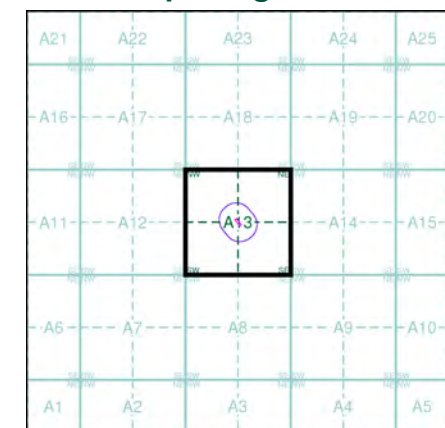
Source map scale - 1:2,500

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

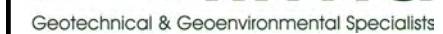
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Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

Site at 275450, 190530



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Published 1899

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.

025 09
1899
1:2,500

025 13
1899
1:2,500

A 5x5 grid of cells labeled A1 to A25. The grid is composed of solid blue lines. The cells are labeled as follows:

- Row 1: A1, A2, A3, A4, A5
- Row 2: A6, A7, A8, A9, A10
- Row 3: A11, A12, A13, A14, A15
- Row 4: A16, A17, A18, A19, A20
- Row 5: A21, A22, A23, A24, A25

Cell A13 is highlighted with a thick black border and a purple circle.

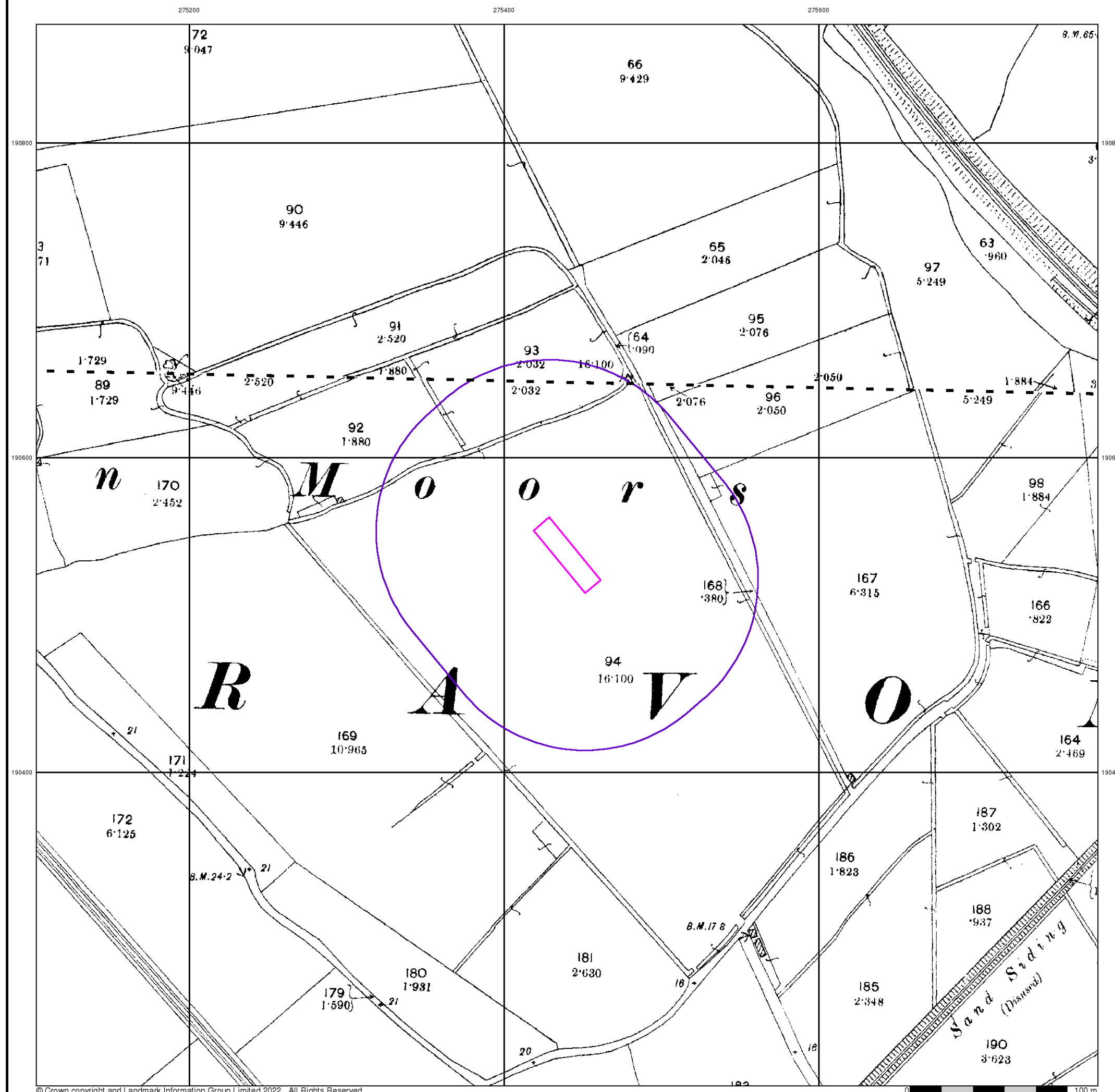


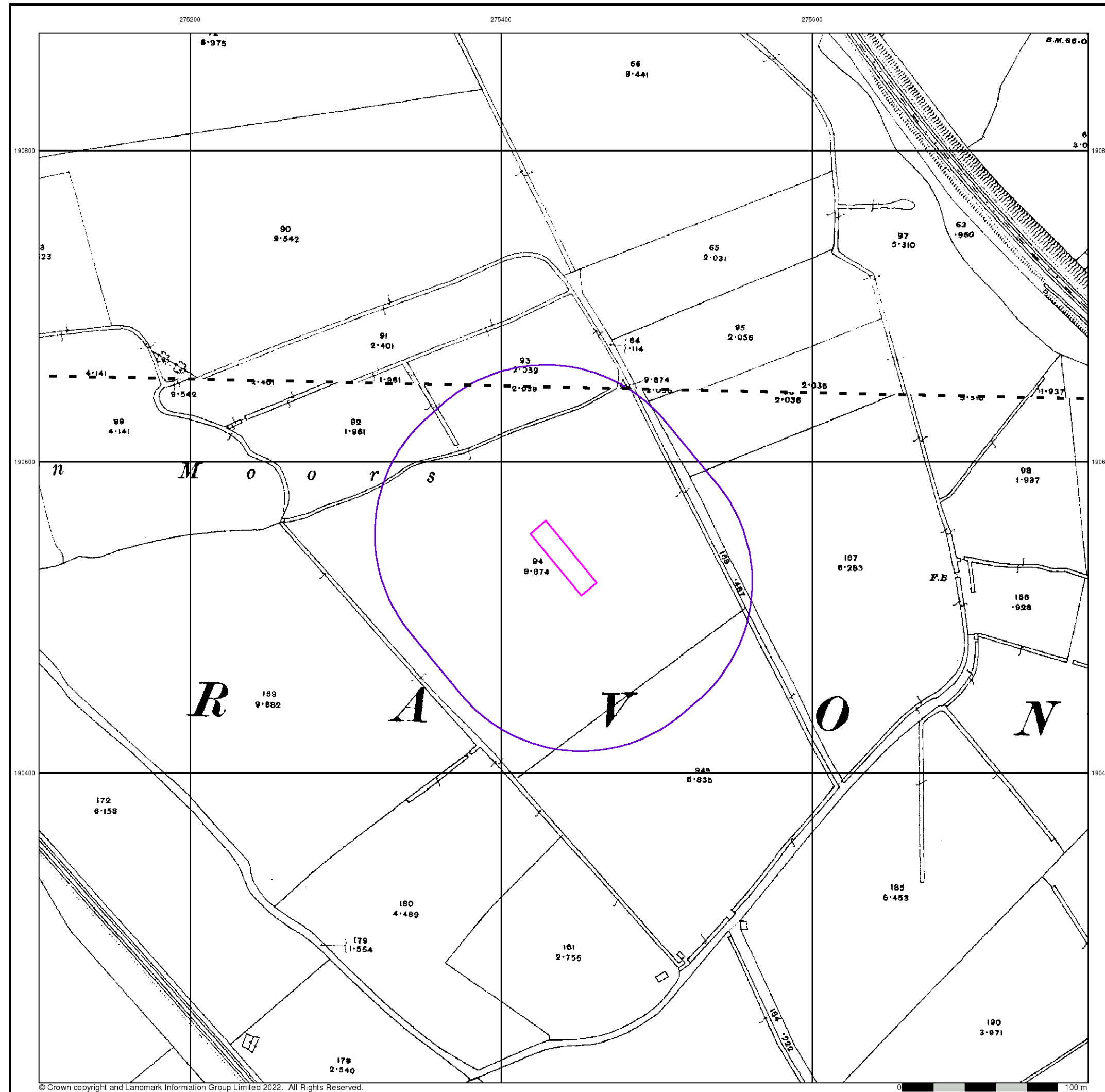
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site at 275450, 190530

Landmark
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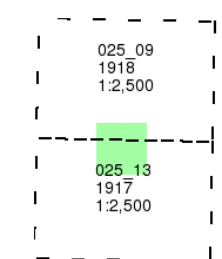
Glamorganshire

Published 1917 - 1918

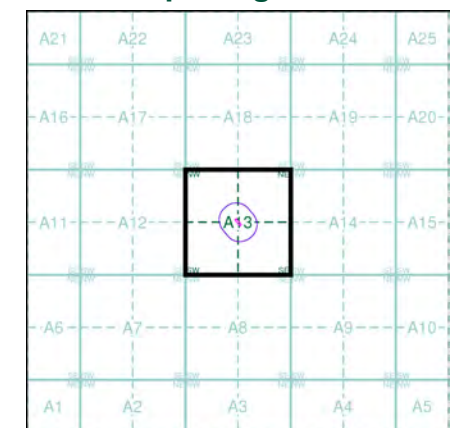
Source map scale - 1:2,500

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

Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

Site at 275450, 190530



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Glamorganshire

Published 1936 - 1939

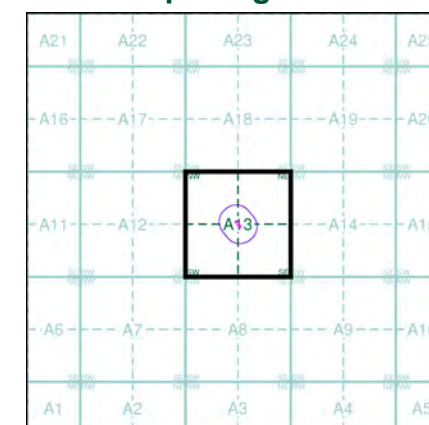
Source map scale - 1:2,500

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)

025 09
1936
1:2,500
025 13
1939
1:2,500

Historical Map - Segment A13



Order Details

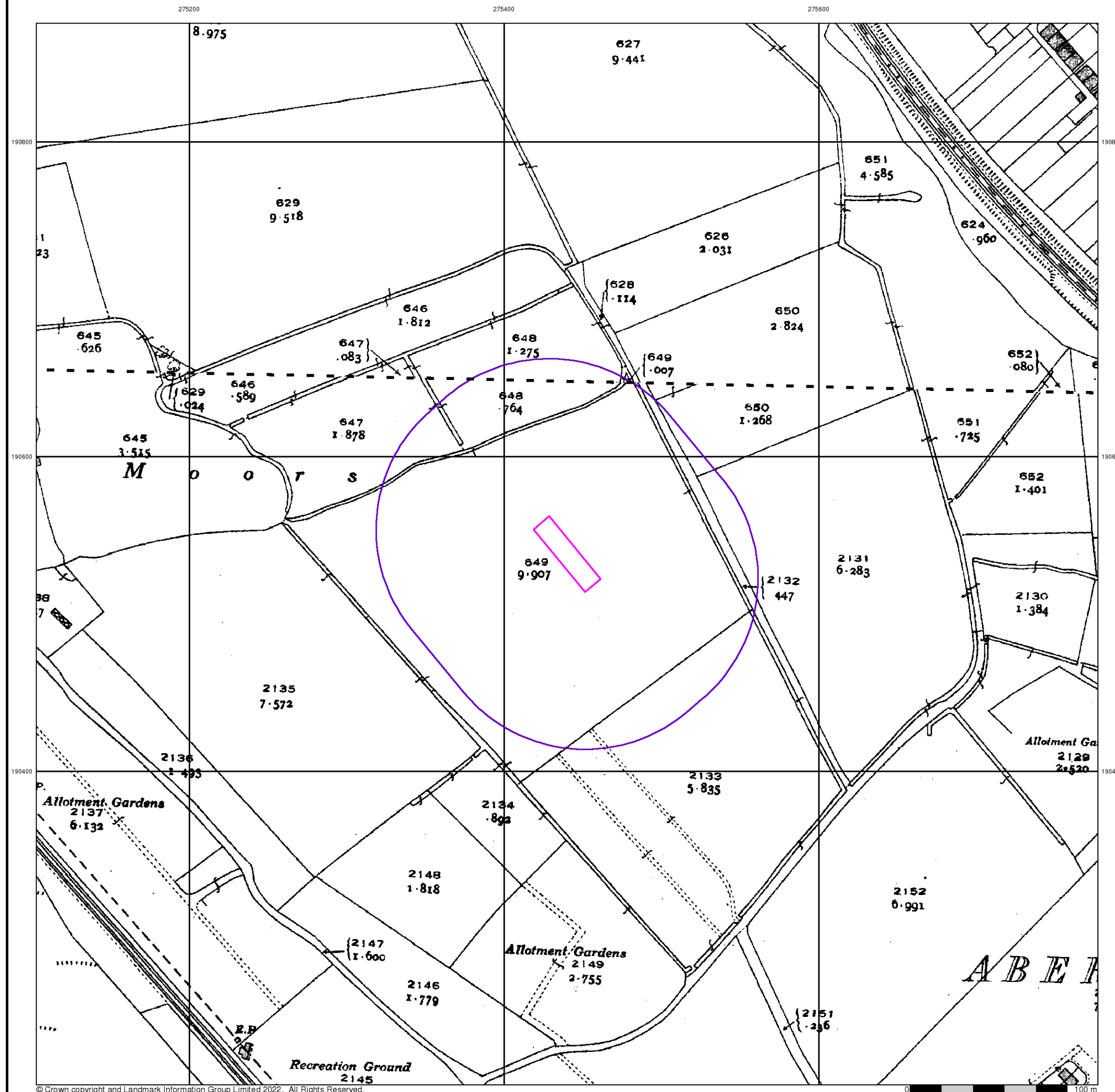
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

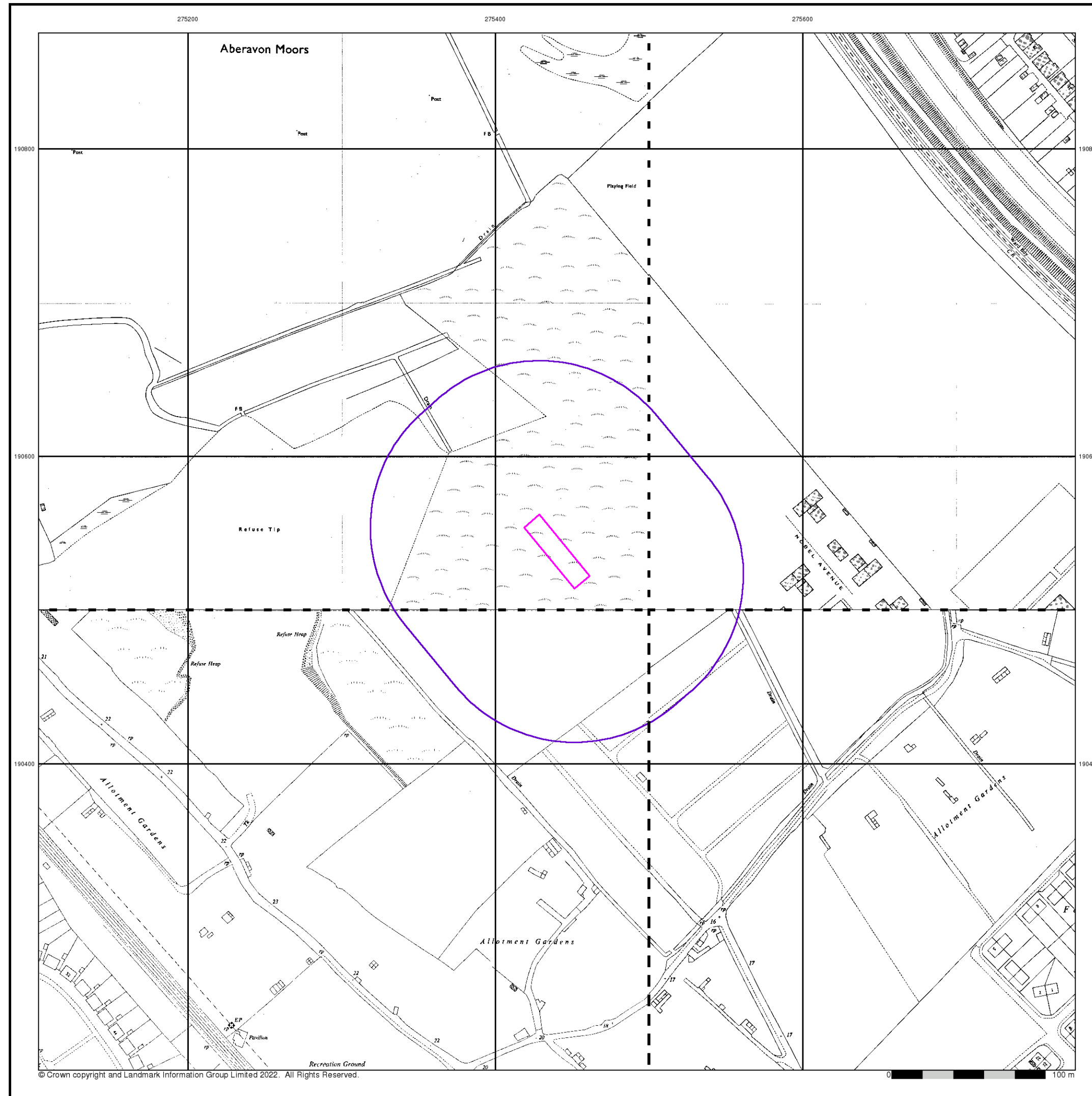
Site Details

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Geotechnical & Geoenvironmental Specialists

Ordnance Survey Plan

Published 1952 - 1971

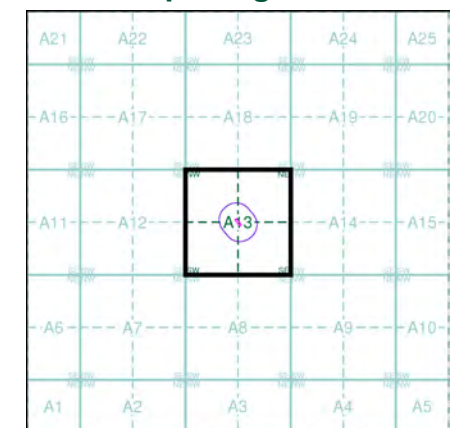
Source map scale - 1:1,250

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)

SS7590NW 1971 1:1,250	SS7590NE 1966 1:1,250
SS7590SW 1952 1:1,250	SS7590SE 1952 1:1,250

Historical Map - Segment A13



Order Details

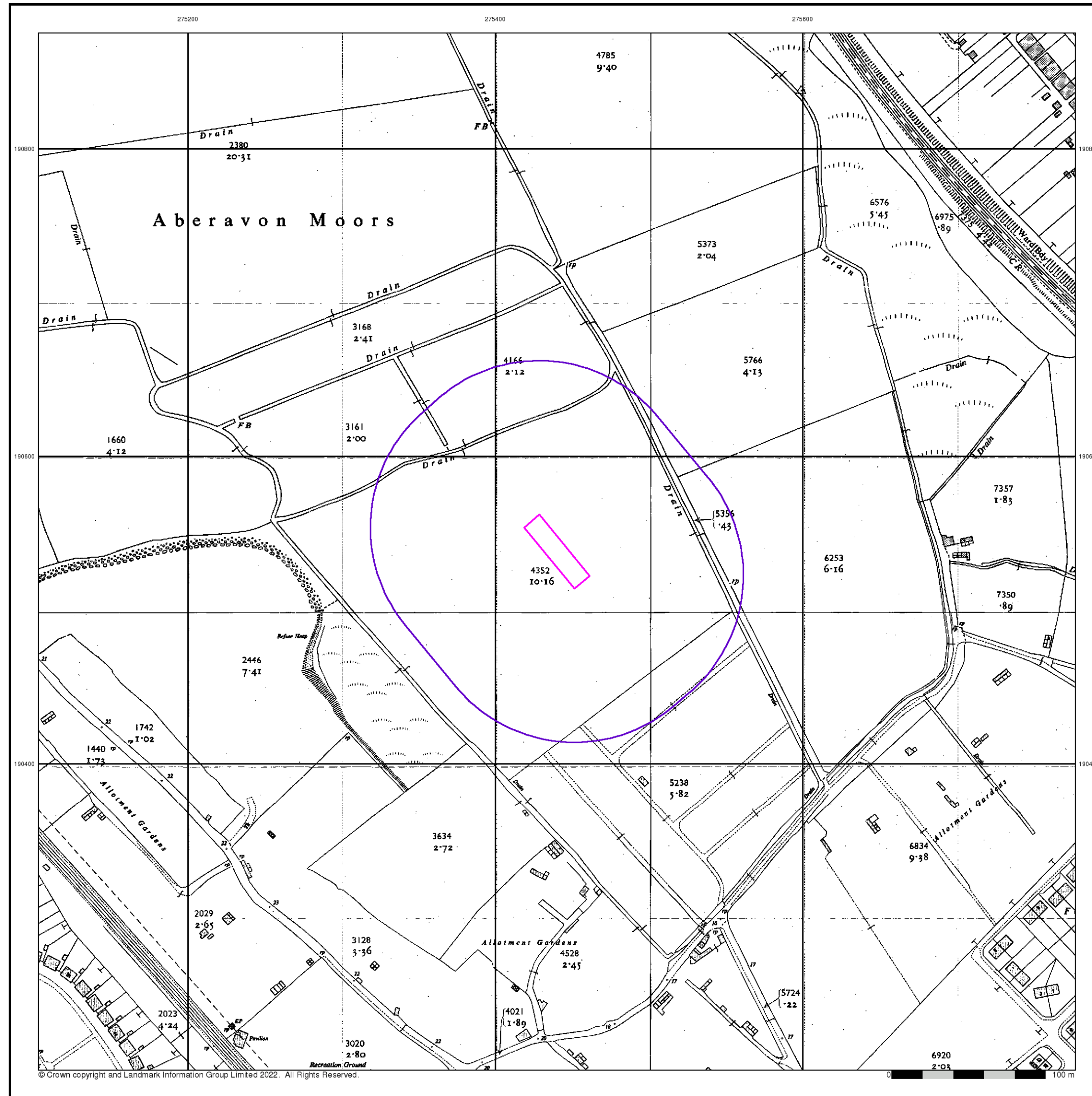
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

Site at 275450, 190530



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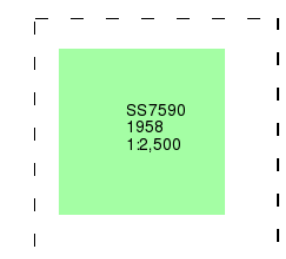
Ordnance Survey Plan

Published 1958

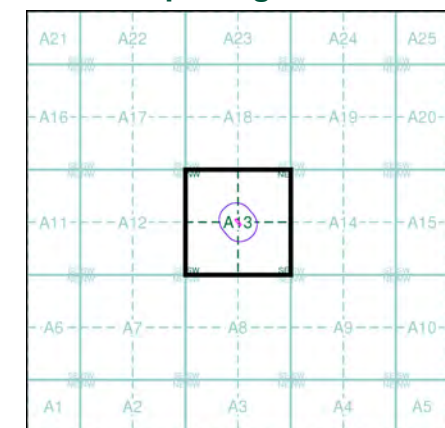
Source map scale - 1:2,500

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

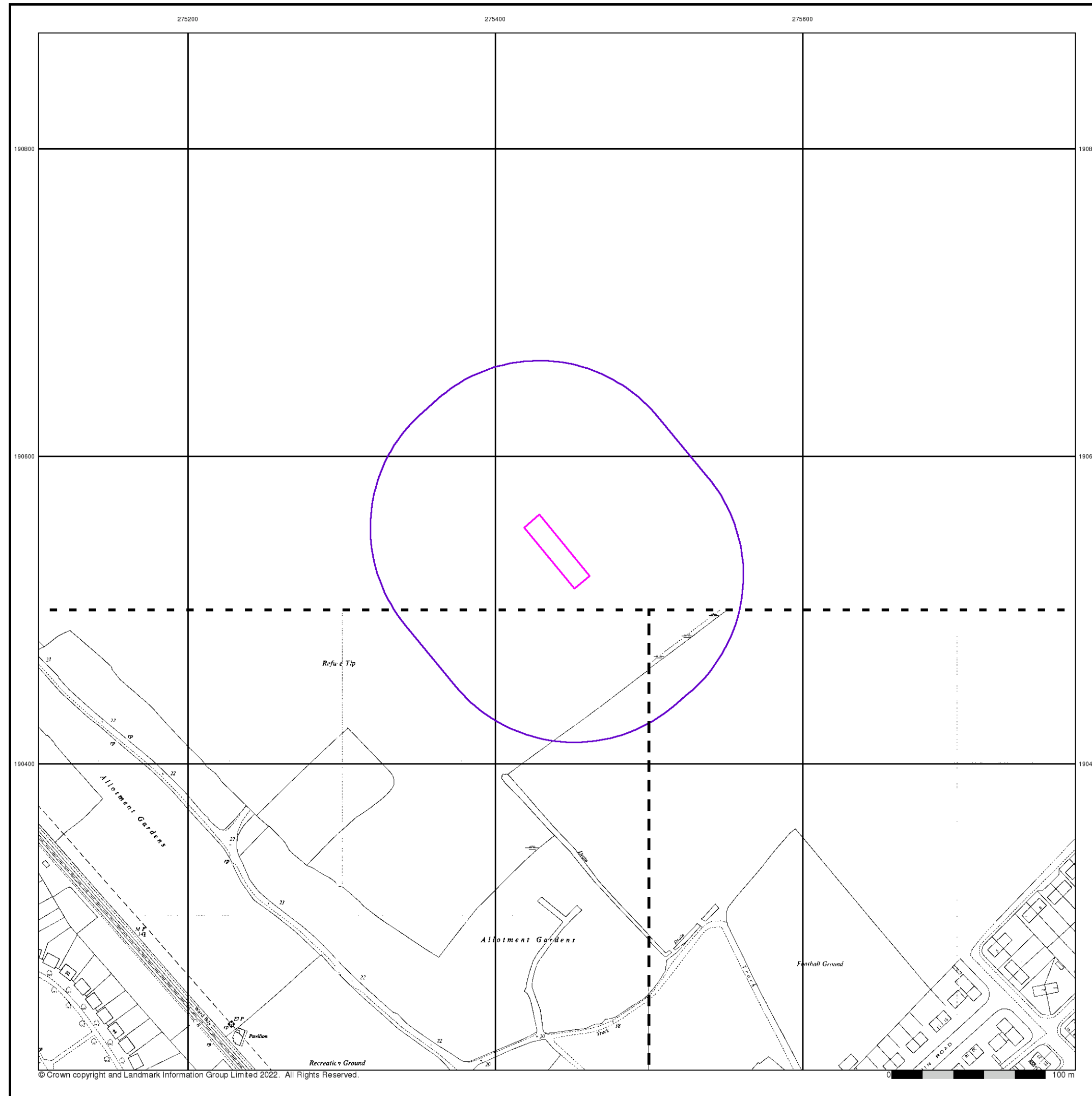
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

Site at 275450, 190530



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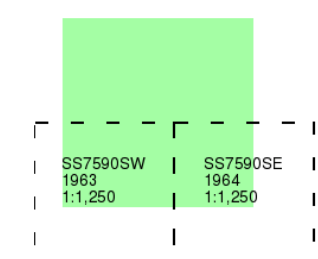
Ordnance Survey Plan

Published 1963 - 1964

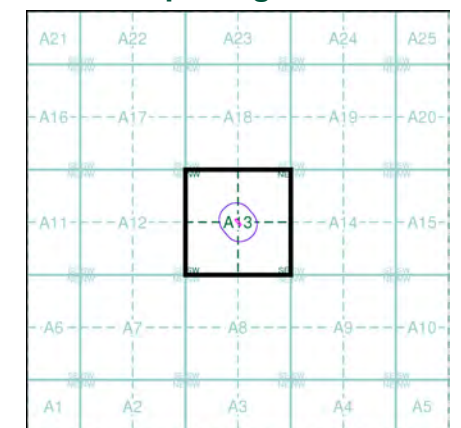
Source map scale - 1:1,250

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

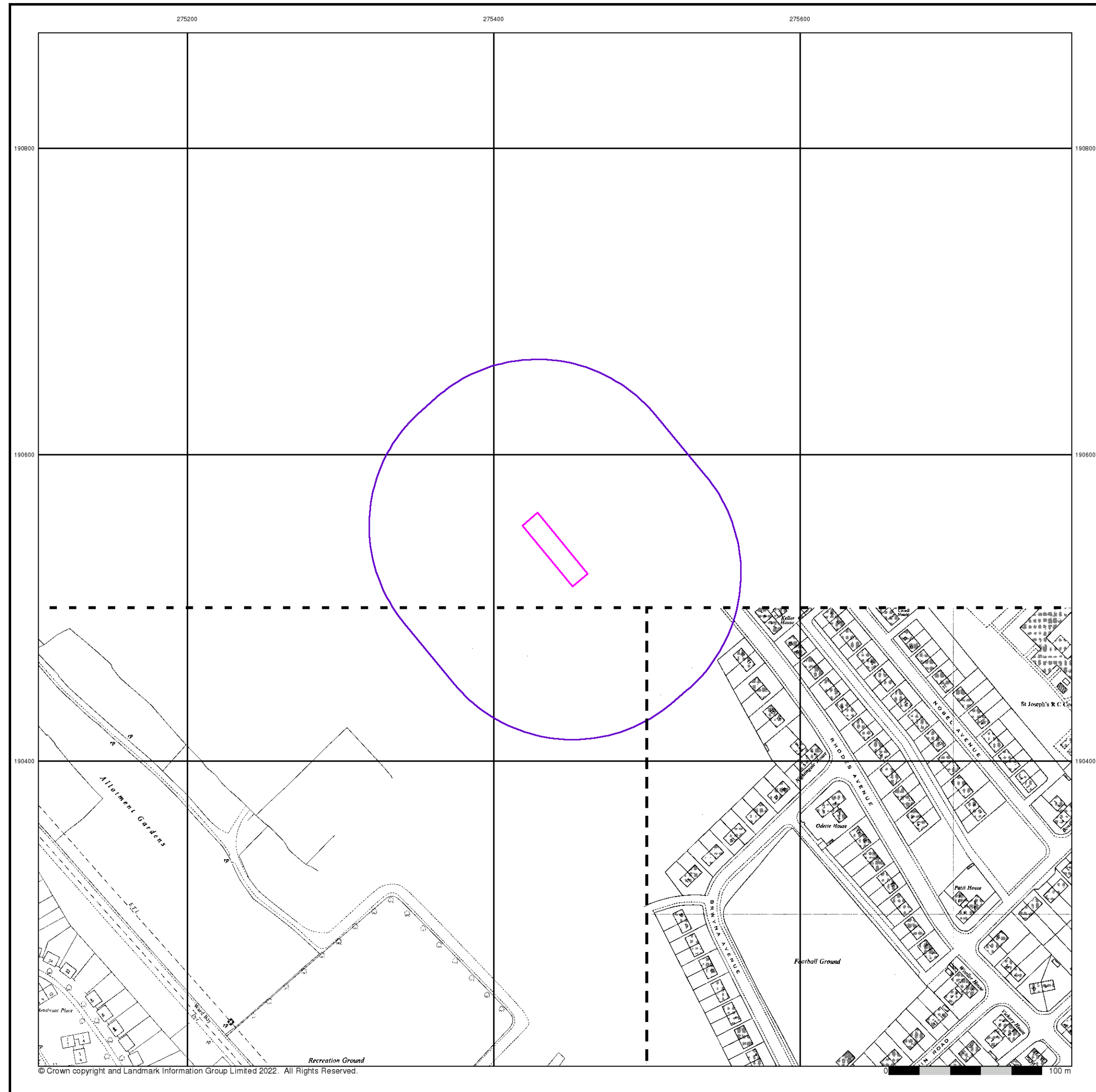
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

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Ordnance Survey Plan

Published 1967

Source map scale - 1:1,250

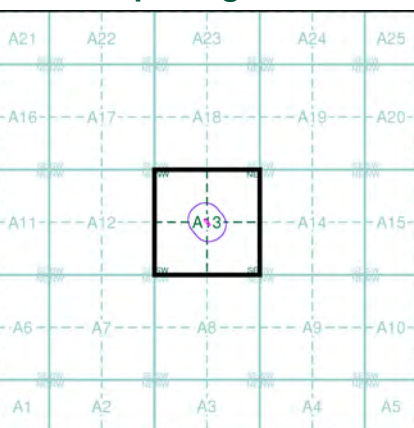
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. 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)



SS7590SW	SS7590SE
1967	1967
1:1,250	1:1,250

Historical Map - Segment A13



Order Details

Order Number:	291876629_1_1
Customer Ref:	17166
National Grid Reference:	275440, 190540
Slice:	A
Site Area (Ha):	0.07
Search Buffer (m):	100

Site Details

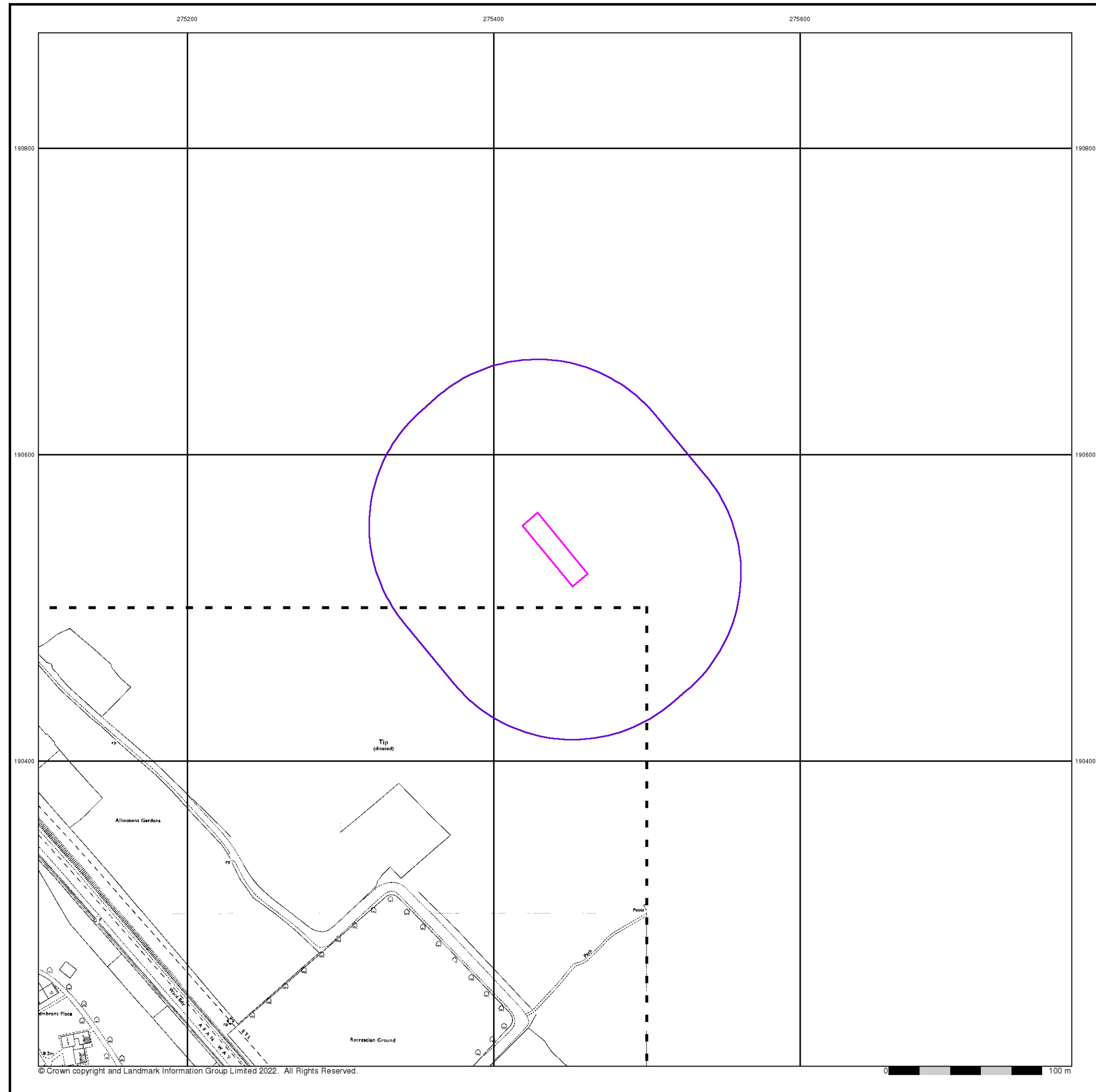
Site at 275450, 190530



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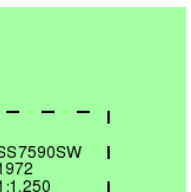
Ordnance Survey Plan

Published 1972

Source map scale - 1:1,250

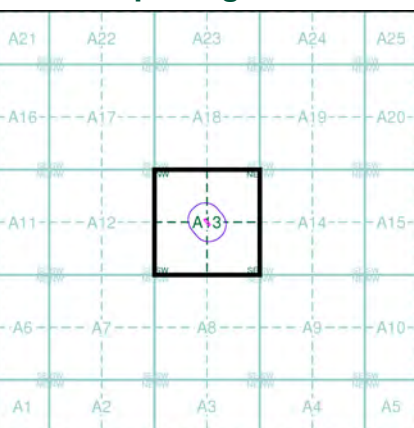
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. 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)



SS7590SW
1972
1:1,250

Historical Map - Segment A13



Order Details

Order Number:	291876629_1_1
Customer Ref:	17166
National Grid Reference:	275440, 190540
Slice:	A
Site Area (Ha):	0.07
Search Buffer (m):	100

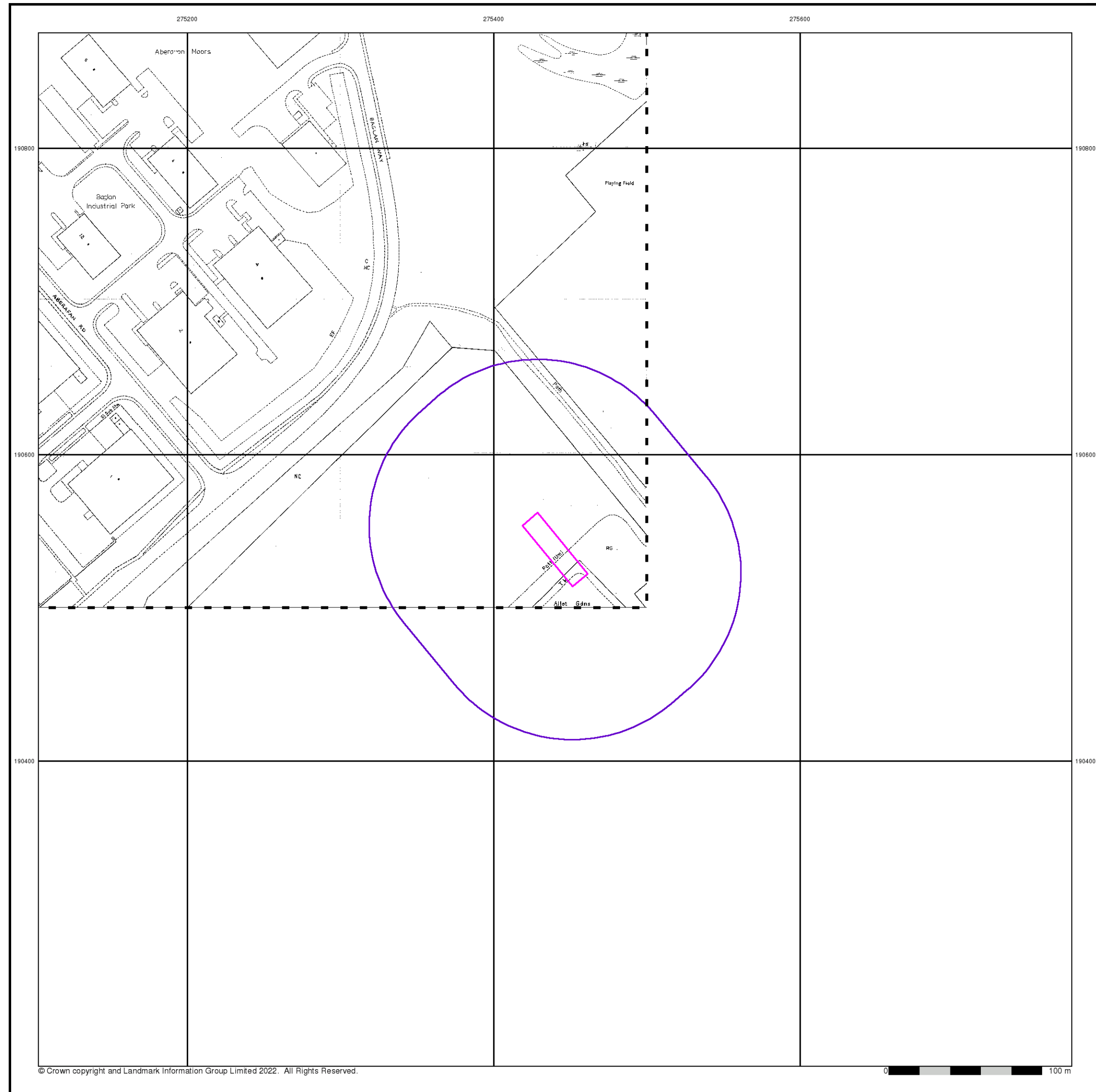
Site Details

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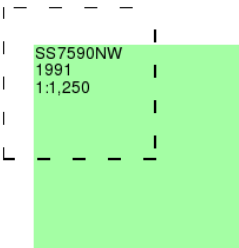
Additional SIMs

Published 1991

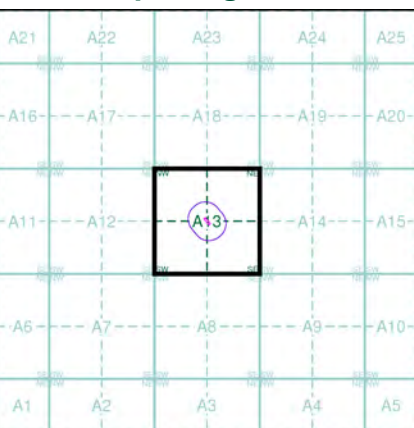
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13




Order Details

Order Number:	291876629_1_1
Customer Ref:	17166
National Grid Reference:	275440, 190540
Slice:	A
Site Area (Ha):	0.07
Search Buffer (m):	100

Site Details

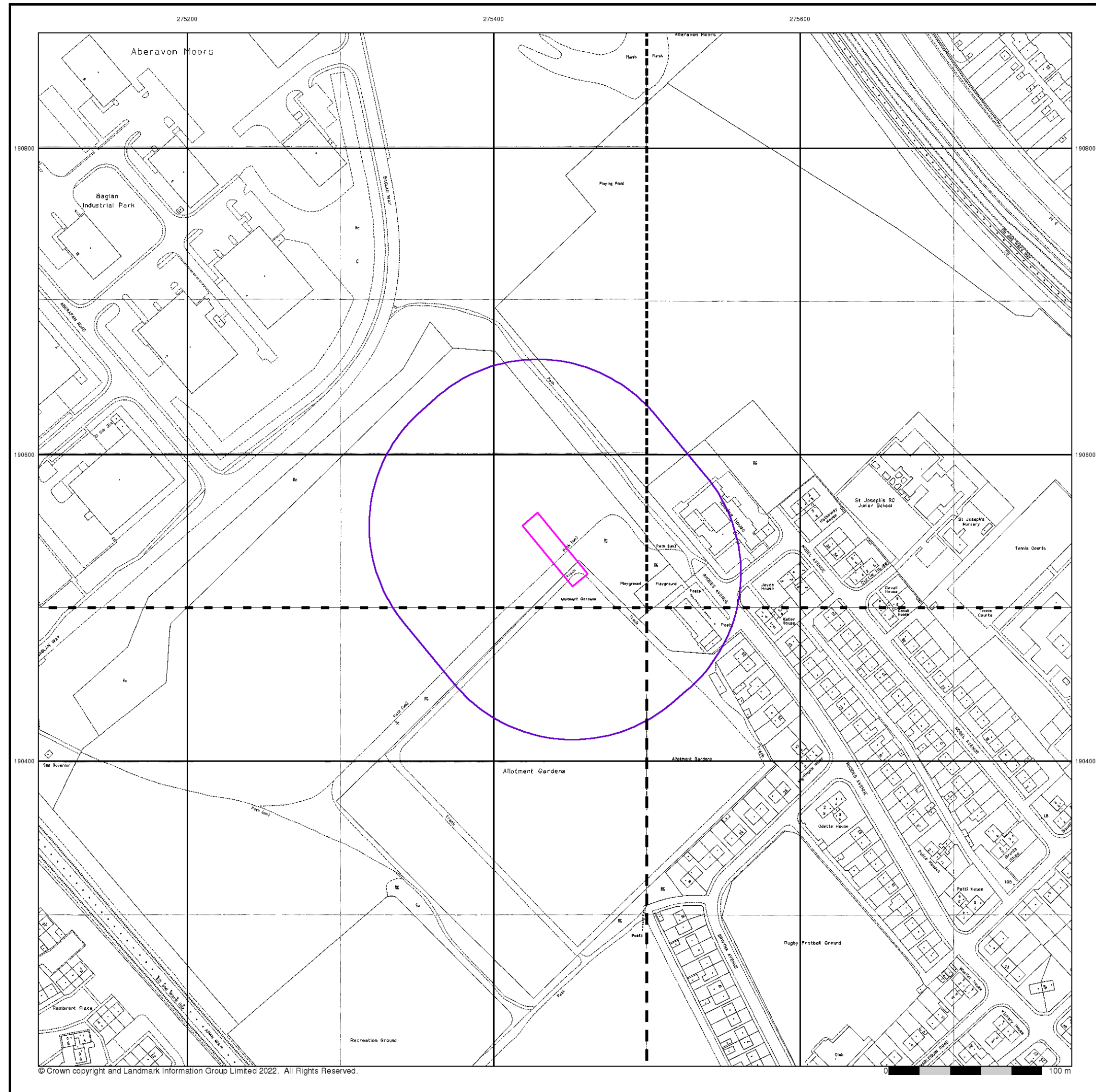
Site at 275450, 190530



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Large-Scale National Grid Data

Published 1993

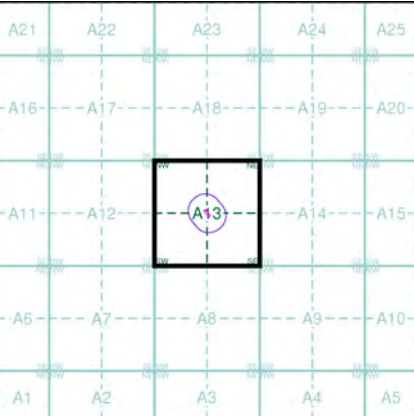
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SS7590NW 1993 1:1,250	SS7590NE 1993 1:1,250
SS7590SW 1993 1:1,250	SS7590SE 1993 1:1,250

Historical Map - Segment A13



Order Details

Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

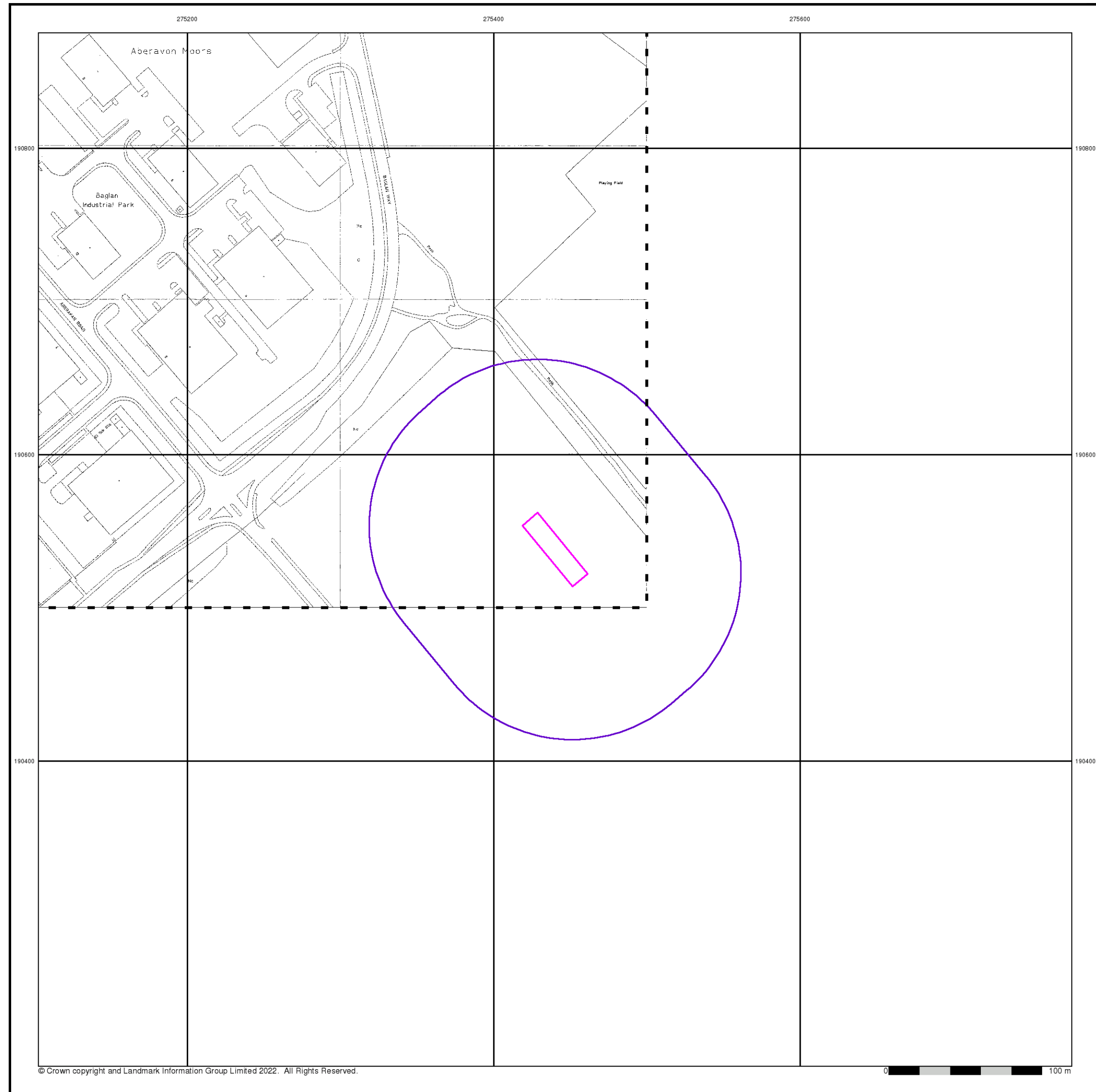
Site at 275450, 190530



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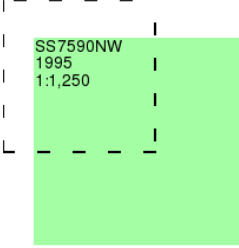
Large-Scale National Grid Data

Published 1995

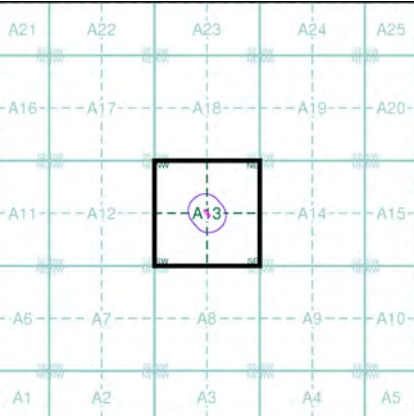
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	291876629_1_1
Customer Ref:	17166
National Grid Reference:	275440, 190540
Slice:	A
Site Area (Ha):	0.07
Search Buffer (m):	100

Site Details

Site at 275450, 190530



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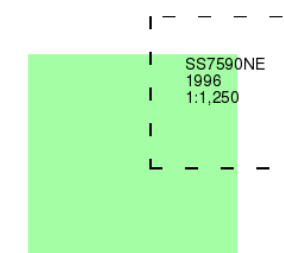
Large-Scale National Grid Data

Published 1996

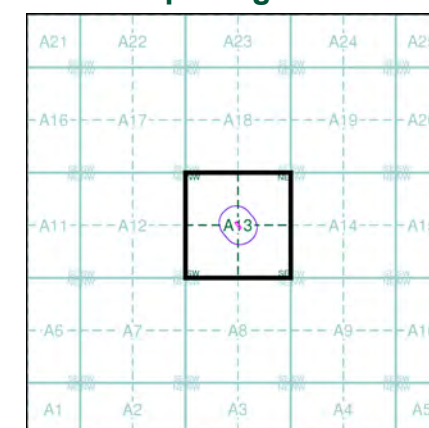
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

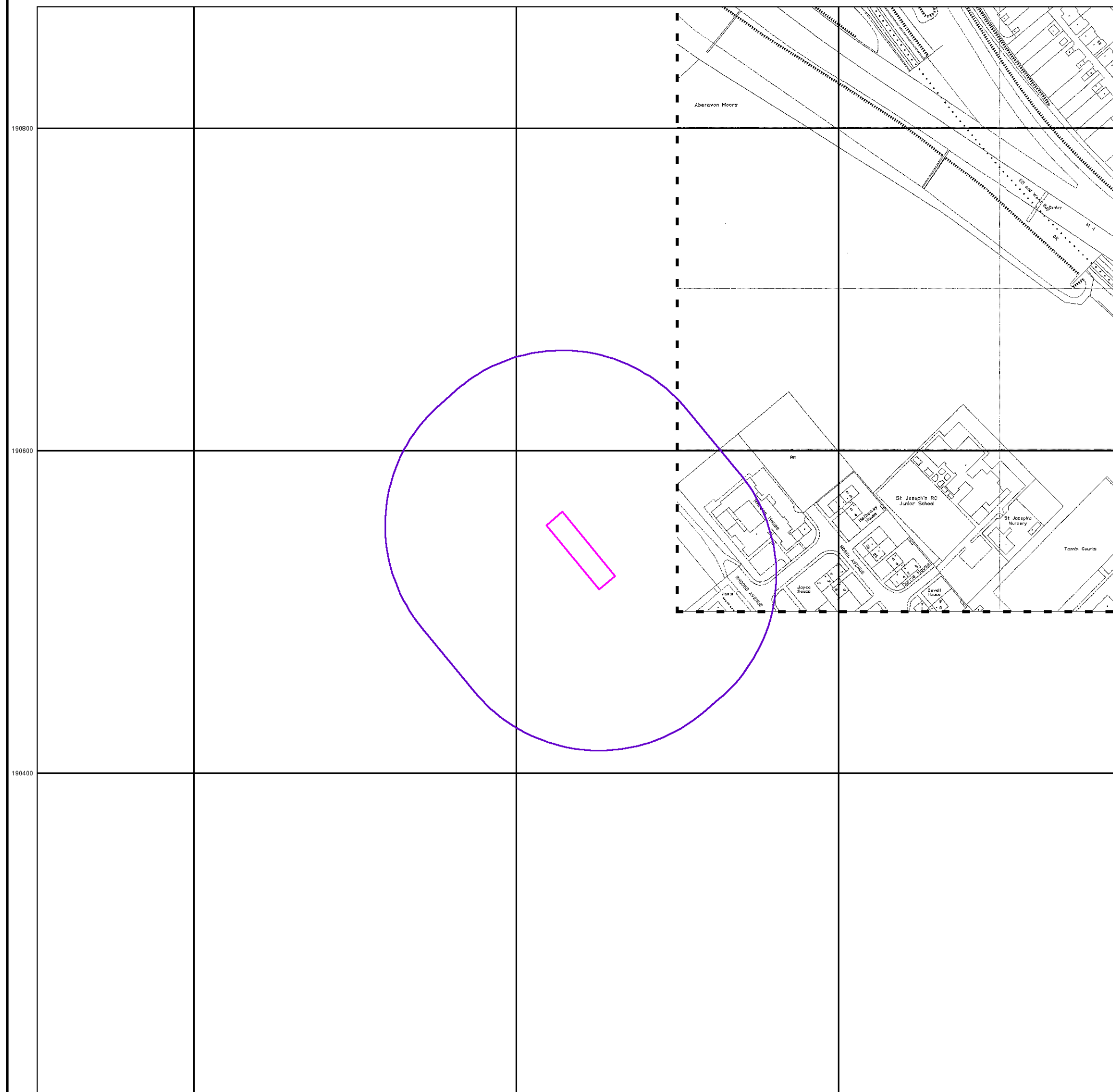
Order Number: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
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Site Details

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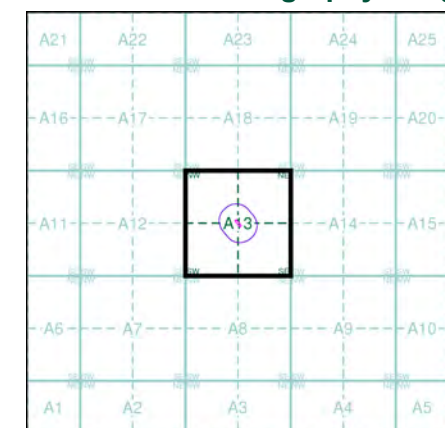


Historical Aerial Photography

Published 2000

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: 291876629_1_1
Customer Ref: 17166
National Grid Reference: 275440, 190540
Slice: A
Site Area (Ha): 0.07
Search Buffer (m): 100

Site Details

Site at 275450, 190530

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

	Gravel Pit		Sand Pit		Other Pits
	Quarry		Shingle		Orchard
	Osiers		Reeds		Marsh
	Mixed Wood		Deciduous		Brushwood
	Fir		Furze		Rough Pasture
	Arrow denotes flow of water		Trigonometrical Station		
	Site of Antiquities		Bench Mark		
	Pump, Guide Post, Signal Post		Well, Spring, Boundary Post		
	285 Surface Level				
	Sketched Contour		Instrumental Contour		
	Main Roads		Minor Roads		
	Sunken Road		Raised Road		
	Road over Railway		Railway over River		
	Railway over Road		Level Crossing		
	Road over River or Canal		Road over Stream		
	Road over Stream				
	County Boundary (Geographical)				
	County & Civil Parish Boundary				
	Administrative County & Civil Parish Boundary				
	County Borough Boundary (England)				
	County Burgh Boundary (Scotland)				
	Rural District Boundary				
	Civil Parish Boundary				

Ordnance Survey Plan 1:10,000

	Chalk Pit, Clay Pit or Quarry		Gravel Pit
	Sand Pit		Disused Pit or Quarry
	Refuse or Slag Heap		Lake, Loch or Pond
	Dunes		Boulders
	Coniferous Trees		Non-Coniferous Trees
	Orchard		Scrub
	Bracken		Heath
	Marsh		Reeds
	Building		Glasshouse
	Sloping Masonry		Pylon
	Cutting		Embankment
	Road Under		Road Over
	Level Crossing		Foot Bridge
	Standard Gauge Multiple Track		Standard Gauge Single Track
	Siding, Tramway or Mineral Line		Narrow Gauge
	Geographical County		Administrative County, County Borough or County of City
	Municipal Borough, Urban or Rural District, Burgh or District Council		Borough, Burgh or County Constituency
	Civil Parish		
	BP, BS		Ch
	CH		F E Sta
	FB		Fn
	GP		MP
	MS		Pol Sta
	PO		PC
	PH		SB
	Spr		TCB
	TCP		W

1:10,000 Raster Mapping

	Gravel Pit		Refuse tip or slag heap
	Rock		Rock (scattered)
	Boulders		Boulders (scattered)
	Shingle		Mud
	Sand		Sand Pit
	Slopes		Top of cliff
	General detail		Underground detail
	Overhead detail		Narrow gauge railway
	Multi-track railway		Single track railway
	County boundary (England only)		Civil, parish or community boundary
	District, Unitary, Metropolitan, London Borough boundary		Constituency boundary
	Area of wooded vegetation		Non-coniferous trees
	Non-coniferous trees (scattered)		Coniferous trees
	Coniferous trees (scattered)		Positioned tree
	Orchard		Coppice or Osiers
	Rough Grassland		Heath
	Scrub		Marsh, Salt Marsh or Reeds
	Water feature		Flow arrows
	Mean high water (springs)		Mean low water (springs)
	Telephone line (where shown)		Electricity transmission line (with poles)
	Bench mark (where shown)		Triangulation station
	Point feature (e.g. Guide Post or Mile Stone)		Pylon, flare stack or lighting tower
	Site of (antiquity)		Glasshouse
	General Building		Important Building

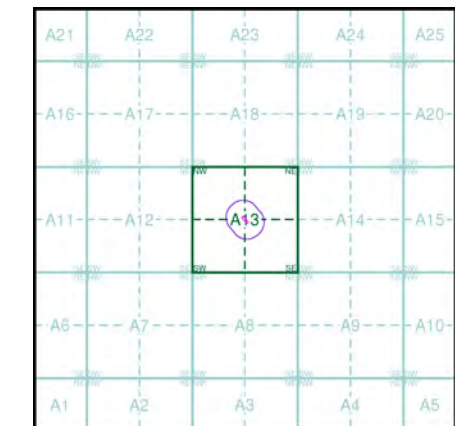


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Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Glamorganshire	1:10,560	1884	2
Glamorganshire	1:10,560	1900	3
Glamorganshire	1:10,560	1921	4
Glamorganshire	1:10,560	1921	5
Historical Aerial Photography	1:10,560	1949	6
Glamorganshire	1:10,560	1951 - 1952	7
Ordnance Survey Plan	1:10,000	1964 - 1965	8
Ordnance Survey Plan	1:10,000	1974	9
Ordnance Survey Plan	1:10,000	1980 - 1982	10
Ordnance Survey Plan	1:10,000	1993 - 1996	11
10K Raster Mapping	1:10,000	1999	12
10K Raster Mapping	1:10,000	2006	13
VectorMap Local	1:10,000	2021	14

Historical Map - Slice A



Order Details

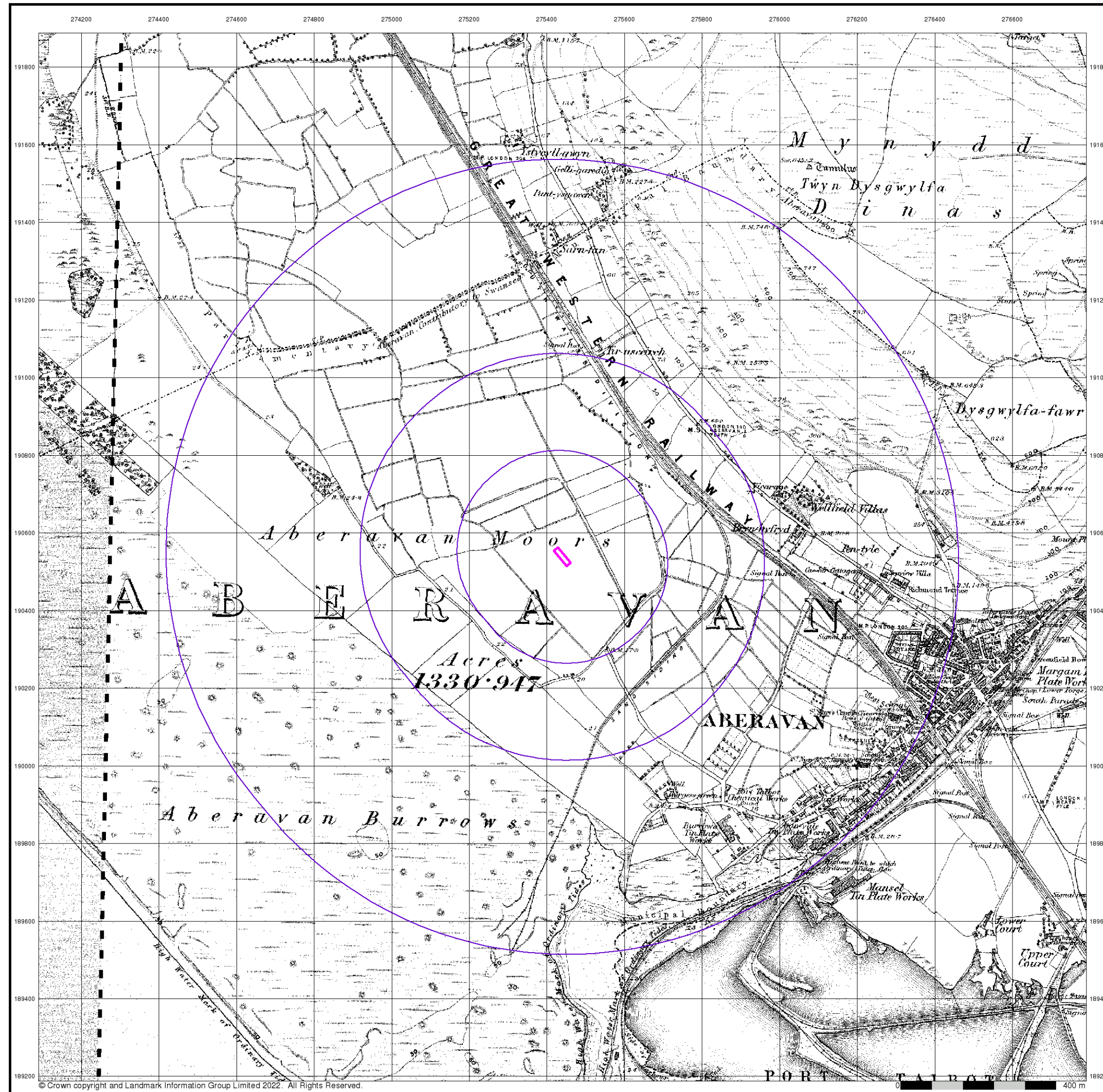
Order Number: 291876629_1_1
 Customer Ref: 17166
 National Grid Reference: 275440, 190540
 Slice: A
 Site Area (Ha): 0.07
 Search Buffer (m): 1000

Site Details

Site at 275450, 190530



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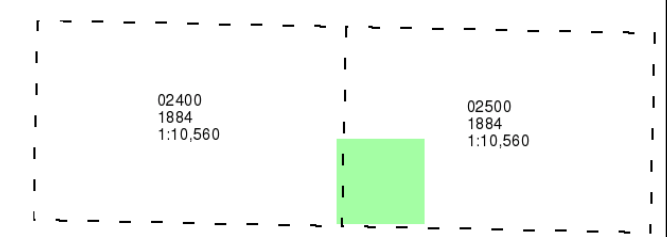
Glamorganshire

Published 1884

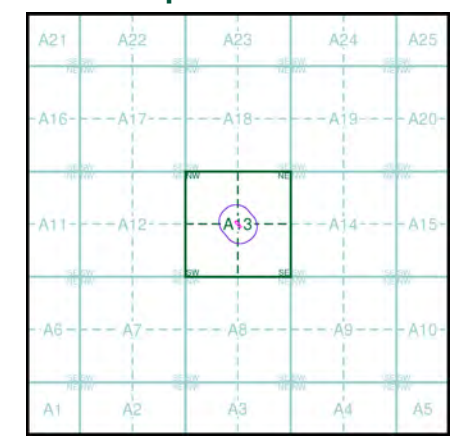
Source map scale - 1:10,560

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



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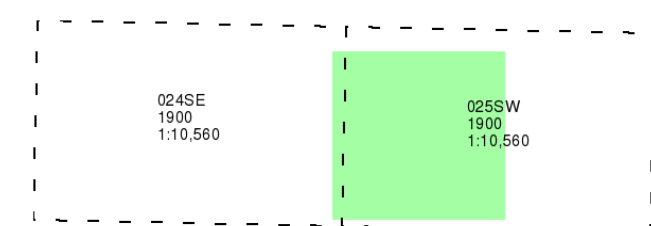
Glamorganshire

Published 1900

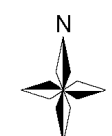
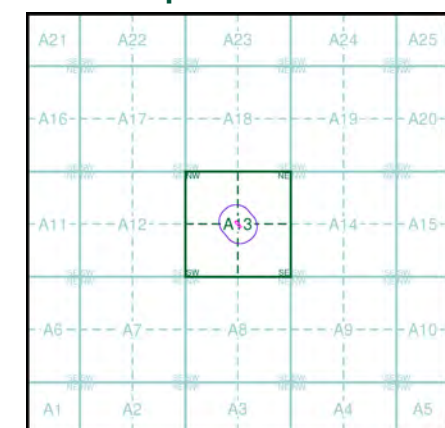
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