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1 Background

B. A. Hydro Solutions Ltd. (BAHS) were commissioned to complete a Hydrogeological Risk Assessment to establish the potential impact on springs located on the Portsmouth Water Head Office site resulting from planned redevelopment of the site. Havant Springs consist of a number of Chalk fed features which occur through the centre of head office site. They provide a significant volume of water to the Company and the majority of the supply to Portsmouth, with a peak of around 60 Ml/day. Supplied with this peak, the membranes at Farlington WTW have a capacity of 85 Ml/d, and have to be run at this level. The spring sources have a long history of providing a consistent flow and quality of groundwater.

Portsmouth Water Limited (PWL) are assessing the potential to redevelop the current site in order to create a more modern and functional head office by consolidating the current activities to the south of the site. A mixed housing development would be created across the northern and western part of the site in order to generate the revenue needed to fund the office plans.

The viability, nature, extent and characteristics of any redevelopment depend on the assessed impact of the proposal on the strategic spring supply. Concerns have been raised within an internal document over the possible impact of the proposal. A document titled *Potential Sale of Portsmouth Water Head Office Site* was submitted to the Board of Directors for consideration in Spring 2014, concerns raised in this document have been incorporated within this Assessment.

BAHS assessed all information available at the time of reporting to form the basis of a hydrogeological conceptual understanding of the site. A lack of site specific hydrogeological information was identified. Consequently a detailed geophysical survey was completed allowing three dimensional modelling of ground beneath the site. This report details the current hydrogeological understanding of the site based on the literature review and field measurements completed in order to assess the potential impact posed by the site plans.

2 Study Objectives

The Study sought to identify and assess the potential risks posed to Havant Springs, with regard to the underlying geology and hydrogeology. This report documents the potential risks associated with the proposed redevelopment of the site from its current use as Headquarters and key water source for Portsmouth Water, to key water source, new offices, and housing.

The objectives set out in the original BAHS scope for the project (letter dated 30th April 2014 – see Appendix A) are as follows:

- To provide Portsmouth Water with a detailed impact assessment to inform and guide the future of the site,
- To form a basis on which Portsmouth Water can manage the retained area of the site and important source of water,
- To inform and guide the development plan for the site for the purpose of Portsmouth Water, developers, planners, Local Authority, the Environment Agency, stakeholders and interested parties,
- To demonstrate that the security and sensitivity of the site is being carefully assessed by identifying potential risks and allowing the implementation of necessary and appropriate precautions,
- To expand the Environment Agency's understanding of the site to enable them to provide appropriate and informed guidance to the planning process, and
- To inform and guide the Local Authority, Planners, etc.

3 Site Details

3.1 Site Location

A site National Grid Reference (NGR) of SU 71150 06240 has been adopted as the centre of the current Head Office site. The site location is illustrated in Figure 1 along with a location map of the surrounding area. A site plan is provided in Figure 2, showing the whole of the Portsmouth Water Headquarters site.

PWL headquarters are located in Havant, Hampshire, off West Street, bounded to the east by an industrial estate off Brockhampton Lane, to the west by Brockhampton Road, and to the south by Solent Road. The Company headquarters moved from their previous premises in Commercial Street in Portsmouth, to the present location, in 1967 (Portsmouth Water, 2007).

The site houses the headquarters of the Company, with offices, stores, laboratory, fleet fuelling depot, Havant Pumping Station (PS) and other buildings, as well as the Havant Springs themselves. There are also two man-made ponds which were originally to supply water to the steam driven engine at Havant PS. Havant Springs is the largest water source available to Portsmouth Water, it is licensed at a maximum daily abstraction rate of 137.0 ML/d, see licence details (Issued 18th February 2010) in Table 1.

Licence No.	Site Name	Max. daily (ML/d)	Annual total (ML/yr)
11/42/36.2/1	Havant Springs	137.0	35,770.0

Table 1: Havant Springs abstraction licence details

There are a number of different activities on the current site, such as water sample testing; use / storage of hazardous chemicals; plant maintenance; site maintenance / landscaping; building maintenance; plant movement; vehicle washing; office usage (foul sewerage); and fuel storage / fleet fuelling, which potentially pose risks to the springs, due to their nature and proximity to the source.

These risks are registered, and mitigation measures proposed and reported, via the Company Drinking Water Safety Plan (DWSP) which records the risks both on and off-site (springs catchment area), and also provides solutions to keep risks as low as possible. As such, Portsmouth Water has had internal restrictions on pesticide use on the site in effect since the late 1990s. Only glyphosate is used on headquarters grounds, and is only applied when there is no rain forecast, to minimise washing of this into the subsurface and posing a risk to the springs (pers. coms. 2014). There are no such external restrictions on the use of any chemicals around the Havant Springs. There are always hazards present on a site, however, the resulting risks may be low, dependent on the likelihood and severity the hazard presents. With mitigation

measures put in place, often risks can be lowered, or minimised. By undertaking regular DWSP inspections, and having mitigation measures in place, Portsmouth Water keep the site risks under control, with these risks presenting a low-medium risk overall to the site. Mitigation measures may include appropriate storage and bunding of hazardous chemicals; restricting access to site; the presence of the clay bund around the springs, and restricting maintenance and plant movement to specific areas of the site.

Redevelopment is to consist of the demolition of the current offices, and relocate these to the meadows in the south of the site, outlined on Figure 3 in green. The area where the offices are currently would be redeveloped to become housing, providing there was no detrimental effect or increased risk to the springs.

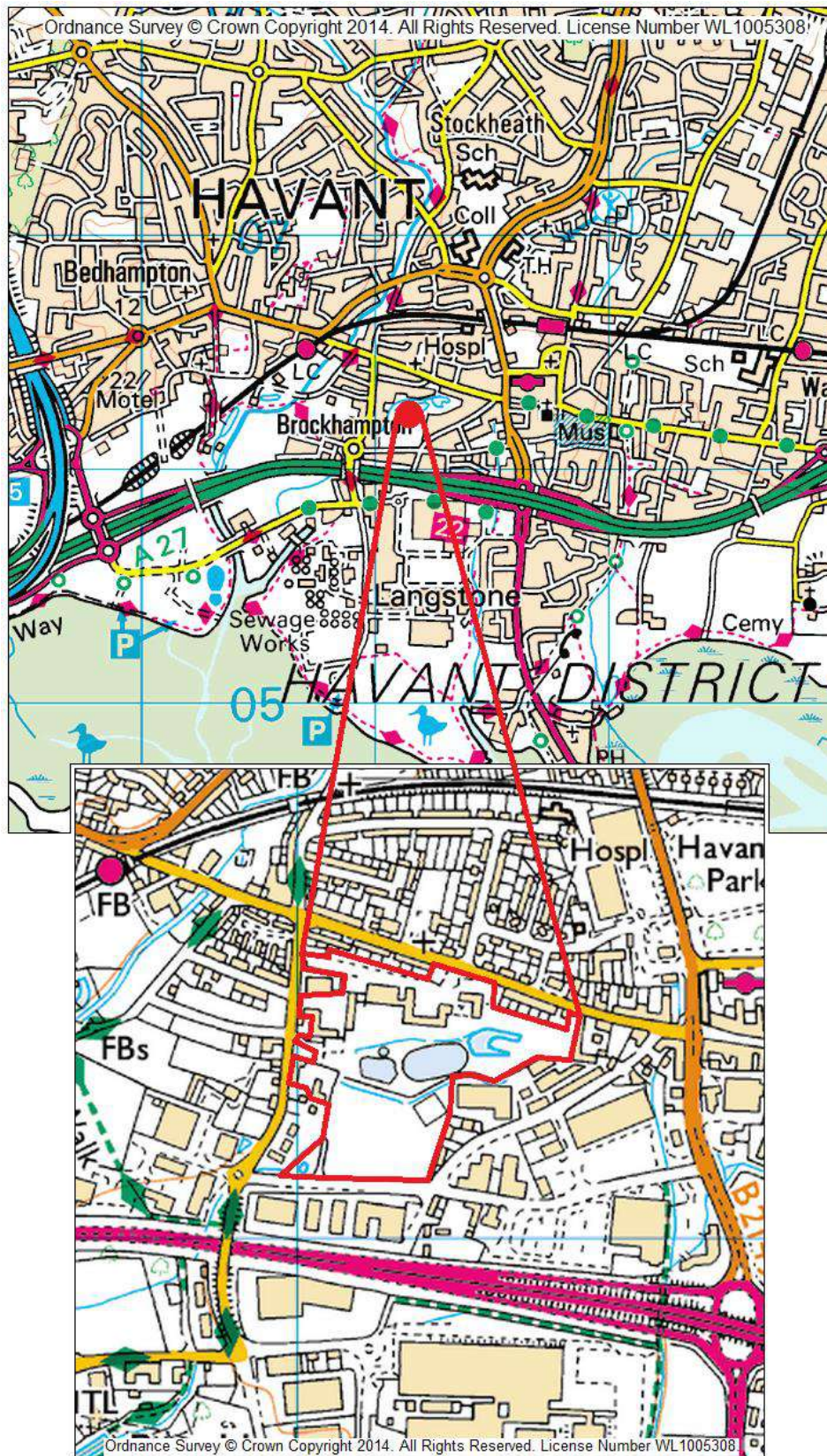


Figure 1: Location Map

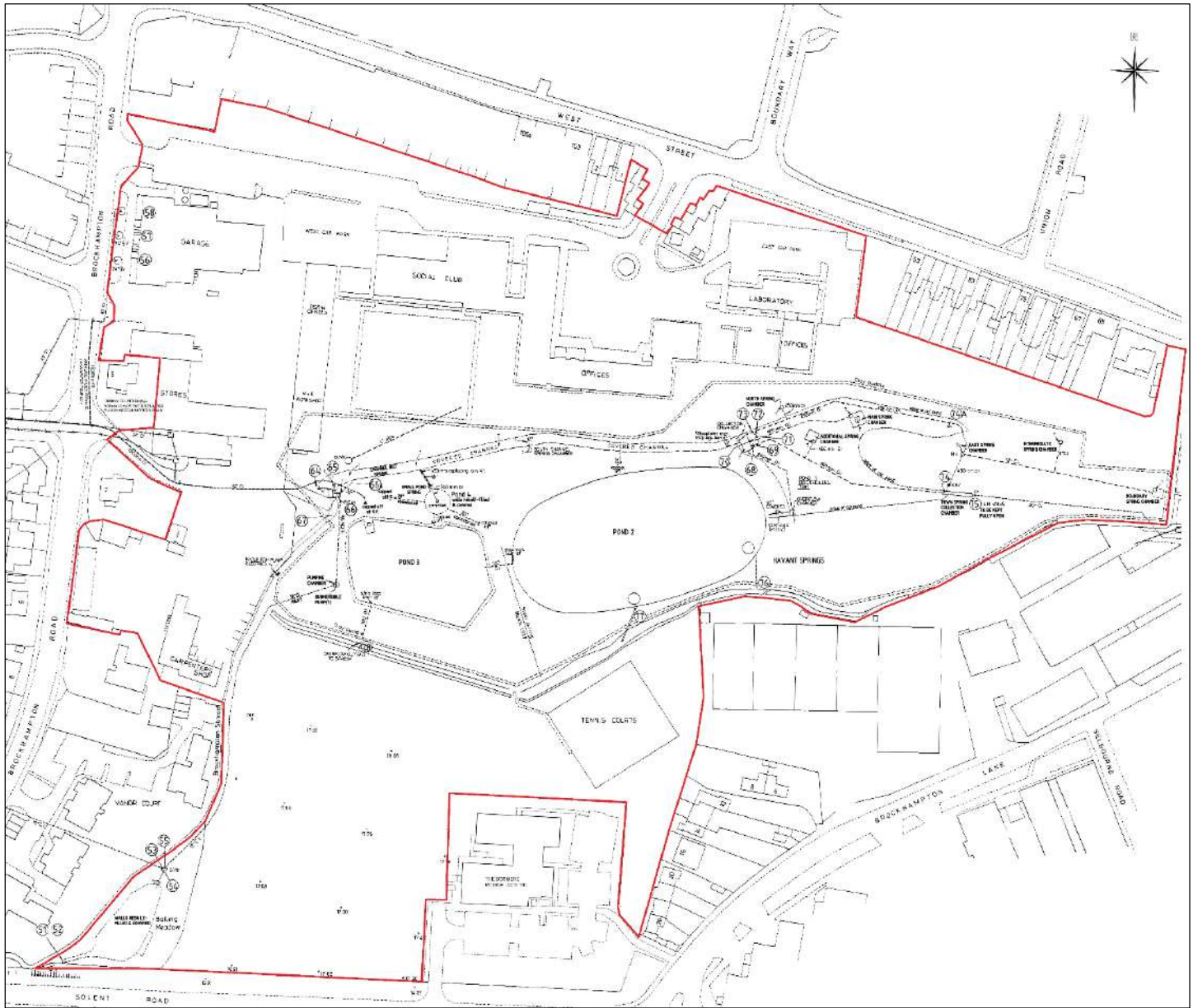


Figure 2: Portsmouth Water Head Office Site Map

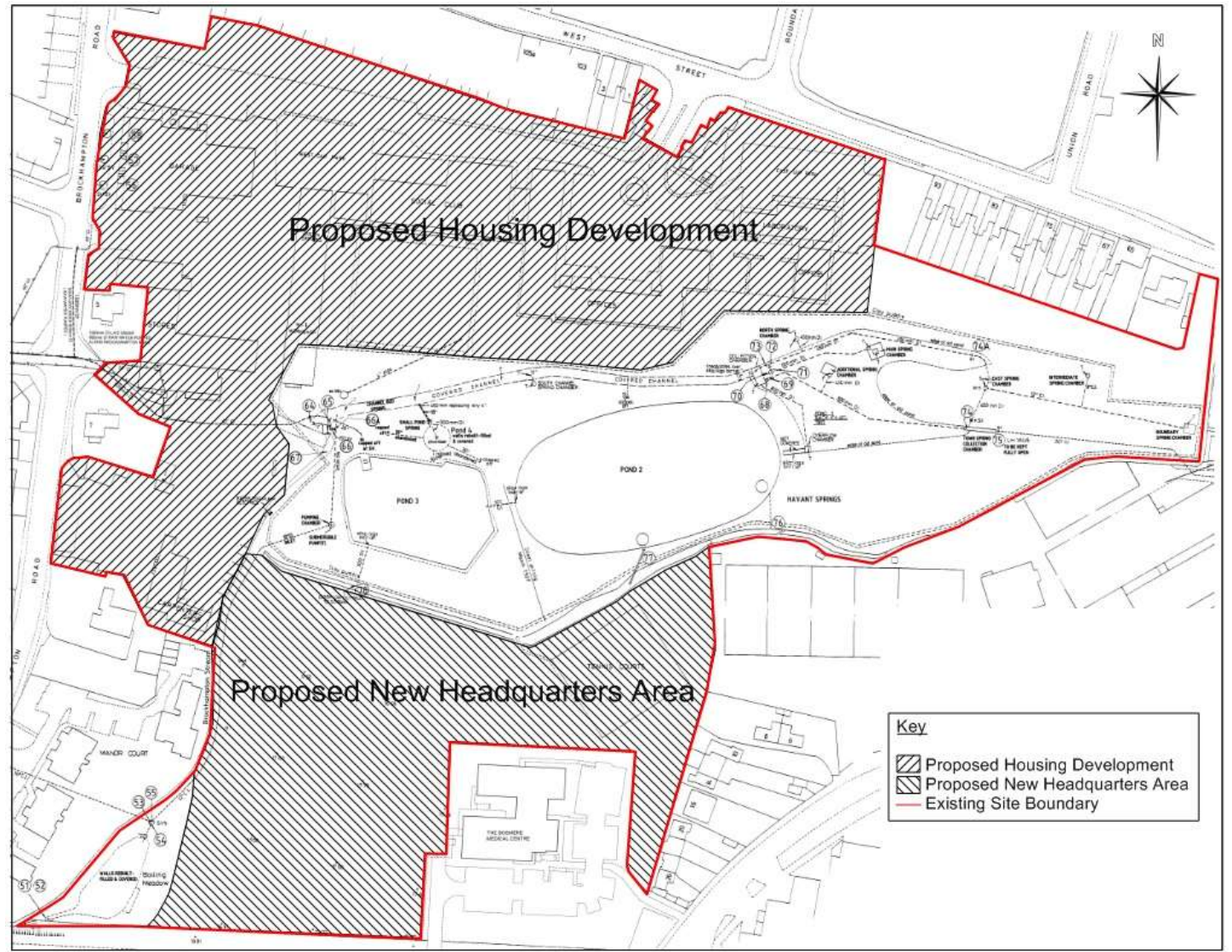


Figure 3: Potential Re-development Areas of Head Office Site

3.2 Havant Springs Timeline

Between 1859 and 1960, Havant Springs were first developed as a principal source of supply for the local water company at the time. Havant Springs run roughly E-W, and are part of 29 separate springs along an approximately 1.5km line extending both east and west from Havant Springs, that provide water for Portsmouth Water. Collecting basins (ponds) were originally used to capture and store water.

Portsmouth Water moved their headquarters from premises on Commercial Road, in Portsmouth, to the Havant Springs site in 1967. Since the original development in 1959, the Havant Springs site has undergone much development, and a gradual enclosing of the springs to prevent pollution to this key source. A brief timeline of events between 1859 and present is listed below to illustrate the changes that have occurred at the site (Portsmouth Water, 2007).

- 1857 – Borough of Portsmouth Waterworks Company (now Portsmouth Water) buys up the Portsmouth and Farlington Waterworks Company
- 1859 – put forward that Havant and Bedhampton Springs be developed as a water source for Portsmouth
- May 28th 1860 – Havant Springs opened as a water source, quickly followed by Bedhampton Springs and then Havant Mill Springs
- 1886 - Clay bund installed around Havant Springs in reaction to the risk of infiltration from cesspits in shallow ground nearby
- 1909 - Filtration began at nearby Farlington Water Treatment Works (WTW) using Slow Sand Filters
- 1923-1927 - Havant PS rebuilt
- 1926 – Chlorination adopted as standard at both Havant and Bedhampton
- Drought 1933-1935 – Havant Springs output dropped, but not below 53 Ml/d
- 1947 - Havant PS changed from coal-fired to oil-fired
- 1956 – Havant Mill Springs enclosed to protect source from pollution
- 1958 – Havant Mill demolished and Havant PS electrified and refurbished
- 1961 – Havant PS chimney demolished on site
- 1964 - Laboratory developed adjacent to Havant PS
- September 1967 – Portsmouth Water Headquarters moved from Commercial Street, Portsmouth, to Havant Springs site
- 1970s – Construction of the A3(M) led to discharge of waste water from construction site to swallow holes higher up in catchment at Horndean and Clanfield, resulting in high turbidities in Havant and Bedhampton Springs
- Late 1980s – Spring chambers around individual springs on site are constructed and the collecting channels enclosed to protect further from pollution
- 1996 – Havant PS refurbishment – new disinfection equipment, motor overhaul and engine house refurbishment

- 1997 – The two man-made collecting ponds used originally for the steam engines on-site were disconnected as supply and retained as ornamental features. Remaining open Spring basins are enclosed on-site
- 2007 – Portsmouth Water celebrates its 150th anniversary

3.3 Surrounding area

Off-site, the Havant area has become progressively built-up, alongside the springs. Havant was well known for leather production between the 1700s – early 1900s, with leather production recorded in 1895 historical maps along Brockhampton Lane, and tannery buildings close-by (see Figure 4). Parchment production was also a large industry for the area, continuing up until the 1930s, which required a reliable, clean water source, so factories were located close to the springs, as well as several breweries in the 1800s. These industries presented a risk to the source of water they were dependent upon, with waste products posing a contamination risk to the springs. The large spring collection basins on-site can clearly be seen on the historical maps.



Figure 4: Portsmouth Water Head Office Site – 1895 (National Library of Scotland)

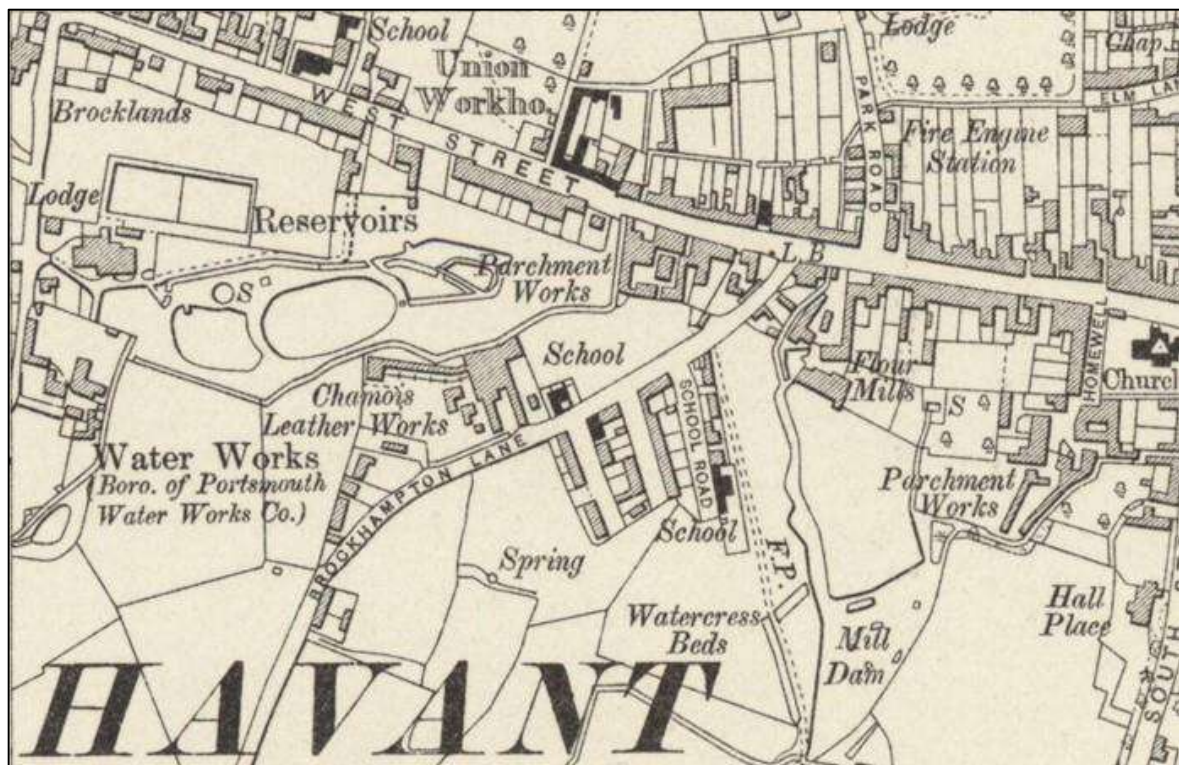


Figure 5: Portsmouth Water Head Office Site – 1907 (National Library of Scotland)



Figure 6: Portsmouth Water Head Office Site – 1938 (National Library of Scotland)

By 1907, the area had not changed much since 1895, with the leather works, flour mills, and school still nearby (Figure 5). However, there is no mention of the tannery on the 1907 map, just to the south-west of the Waterworks. By 1938, the parchment works appears to no longer exist, and more housing has sprung up to the south of the Waterworks site (Figure 6).

After World War Two (WW2), post-war housing sprang up on the northern side of West Street, and now the Havant Springs site is bordered by housing to the north, and recent industrial estates to the east, west and south. The site is to some extent, hemmed in by development on all sides. New potential contaminant risks were introduced into the area close to Havant Springs during this development, and remained a threat since although with no observed impact documented.

Today, the site can be seen to be surrounded by industrial units, and housing. The two collection ponds for the steam engine are clearly visible from the air, along with the collection chamber. The centre of the site is still fairly unchanged, with green space surrounding the spring chambers and collection channel, as well as the meadows in the south of the site, and the Boiling Meadows spring in the far south-west of the site, marked in Figure 7 with a red circle.

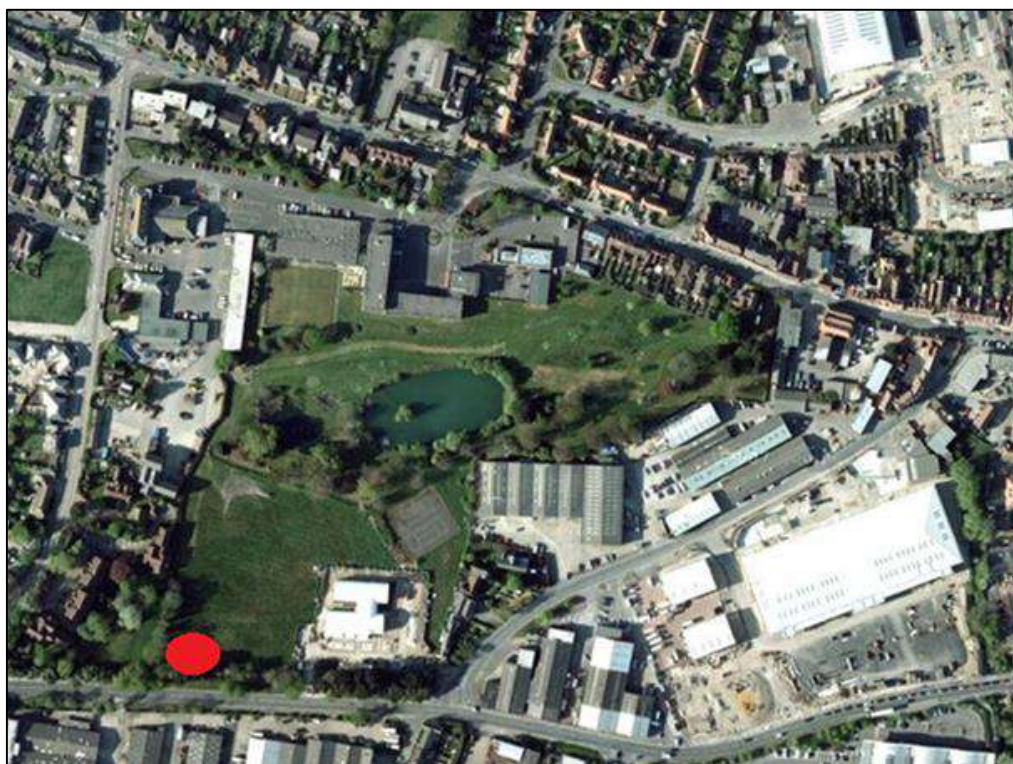


Figure 7: Portsmouth Water Head Office Site – 2014 (Ordnance Survey, 2014)

4 Data Collection / Literature Review

Prior to the risk assessment being produced, a data collection period, and literature review were undertaken to gather all relevant information available at the time relating to the Havant Springs and wider site. This was in order to understand the site, local area and influences, and establish if any further data was required to produce the Assessment. Information and data from various sources were gathered and reviewed, a substantial volume provided by Portsmouth Water records office. A summary of the documents and sources listed in the Bibliography are provided below:

- PWL historical publications
- Academic publications
- Borehole logs from the British Geological Survey
- Geological & hydrogeological maps from the British Geological Survey
- Groundwater modelling & other reports from PWL
- Water Quality data from PWL
- Drinking Water Safety Plan (DWSP) from PWL
- Topographical surveys from PWL & Ordnance Survey
- Geological Desk Study report(s) from various sources
- Ground Investigations Study reports (off-site) from various sources
- Springs abstraction data from PWL
- Rainfall data from PWL & Met Office
- Historical and aerial maps from various sources

A review of the site data confirmed that there was little information on the geology and hydrogeology of the site itself within the data examined. The one site investigation report available for a site immediately adjacent to the east (REC, 2014), provided geological data to a maximum of 4.5 metres below ground level. Trial boreholes were sunk into the drift overlying the Chalk across that site, but did not extend through the full thickness, so the Chalk was not encountered during the works. An historic report (Thomson 1897) mentions the creation of a clay bund around the springs comprising of trenches being dug down to key into clay and/or Chalk before the trenches were filled with puddle clay. Little other detail is documented apart from the bund being between 10 and 30 feet deep in order to key into firm strata and form a barrier to contaminated shallow groundwater from off site.

The East Hampshire and Chichester Chalk (EHCC) groundwater model was upgraded by the Environment Agency and ENTEC, between 2006 and 2008. Havant Springs

are mentioned within the model area, but in a catchment context there is little site specific information. The model sets out a regional groundwater transport mechanism that helps understand how groundwater flow in the area is affected by the geology and geological structures, with springs emerging along these structures (ENTEC, 2006).

A review of the water quality data shows that the springs are largely unaffected by pollutants that often occur at unconfined aquifer sources. Pollutants such as hydrocarbons and solvents rarely feature at the site. In data gathered between 2001 and present, occasional increases in some metals were identified, with these appearing to coincide with periods of increased rainfall. It is therefore thought that these events are related to high turbidities generated over the swallowholes up-gradient in the catchment on the South Downs, close to Horndean, which provide fast routes for the groundwater to reach the springs (Atkinson & Smith, 1974).

It was concluded after examining all the data, that further information on geology and hydrogeology at the site was required. This was felt necessary in order to provide a thorough understanding of the springs, and allow the creation of a hydrogeological conceptual model for groundwater transport and emergence at the site. The conceptual model could then be used to look at the relative risks posed by on-site activities and assess their potential impact, should the site be redeveloped in the future. The depth to the top of the Chalk across the site was identified as a key piece of missing information, as well as understanding the nature of the drift material overlying the Chalk. The mechanism for groundwater transport and emergence at the site, and the effects of the geology and structural geology, was thought to be key to understanding the potential risks at site.

As well as allowing the study to identify areas where there was a lack of information, the literature review provided valuable information and evidence which is referenced throughout this report in the relevant sections.

5 Geology

The combined drift and solid geology map in Figure 8 illustrates the geology mapped at ground level in the local area of Havant, with the location of the Portsmouth Water headquarters outlined in red. The Chalk is not seen on this map as it does not outcrop at ground level locally, although it is close to ground surface in many places.

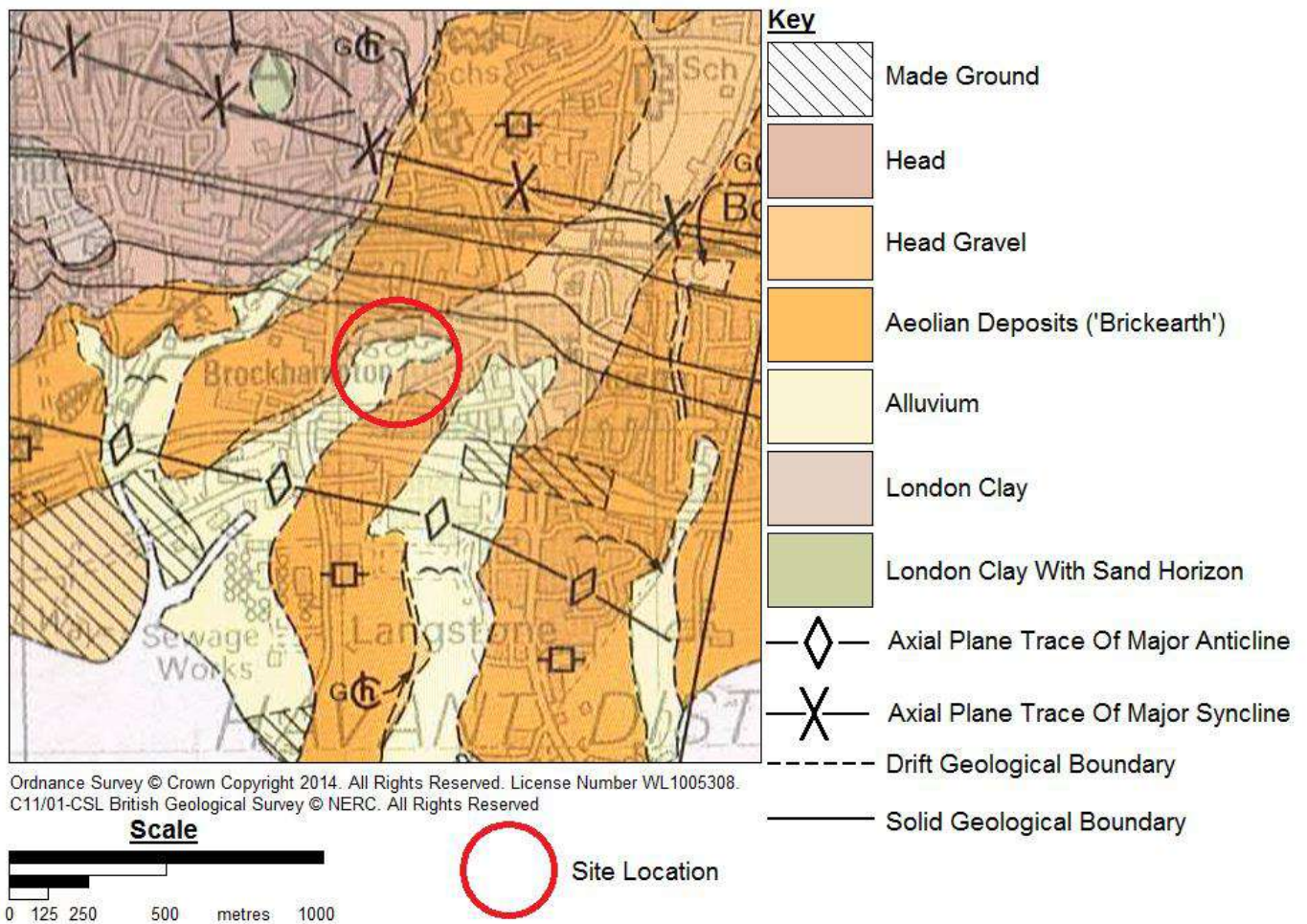


Figure 8: Geological Map

The Havant Springs site is located on a layer of gravelly head deposits and alluvium which rests on the Upper Chalk, and may in the very north of the site, be on the edge of the Reading Formation, which overlies the Chalk. The Chalk is differentiated into a number of units, the Portsdown Chalk is expected to be present close to ground level followed by the Spetisbury Chalk Member. This is followed by the Tarrant Chalk Member, collectively these Members represent the topmost units of the Upper Chalk.

Geological maps show the Reading Formation outcropping at the northern edge of the PWL site, the exact boundary between it and the Chalk is unclear. The geological

boundary may occur just on the northern extent of the site, but little evidence has been found for its occurrence on the site. The far north-west corner of the site may have a thin layer of the Reading Beds present, but this has not been proved by auguring or other further investigation. Similarly there may be a wedge of Reading Beds on the Chalk just south of the centre of the site, see cross section in Figure 24. Figure 9 provides the geological profile from ground level downwards, the lithological summary is based on local borehole records and from Jones and Robinson (1999).

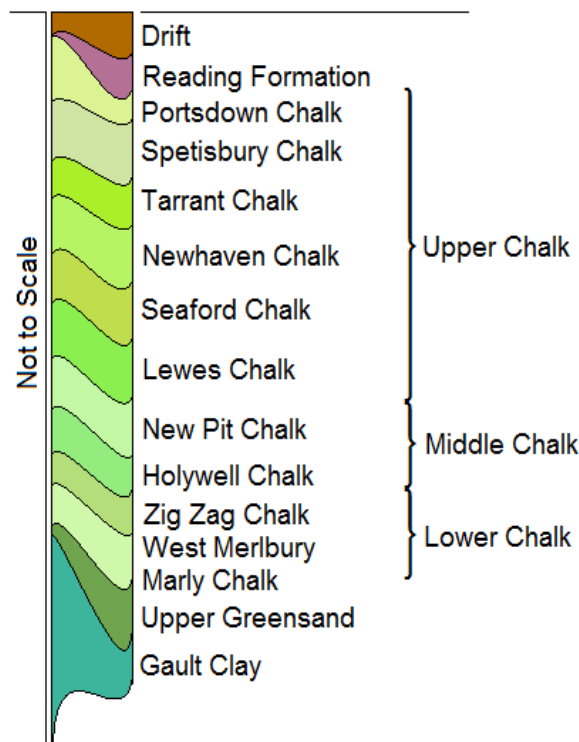


Figure 9: Schematic Lithological Log

Various drift deposits lie uppermost across the site, through the middle of the site, and becoming more widespread towards the south, is a layer of alluvium. Alluvium in this area is generally composed by soft, grey clay, silt and sand, with lots of gravel flint inclusions; organic peat layers may occasionally be encountered. This layer is thought to thin out to the north and be thicker around the southern margins of the site.

Outcropping around the margins of the alluvial and extending beneath is a layer of drift deposit known as Head Gravel. This unit extends to the north, bounding the course of an unnamed stream which runs through east Havant. The Head Gravels are described locally as being composed primarily of flint cobbles and gravel, highly compacted, within a brown sandy clay matrix. This horizon underlies all of the site

extending beneath the alluvium and another drift unit which is present to the north and the south of the site known as the Aeolian Deposits

The Aeolian Deposits, also known as ‘brickearth’ are generally wind-blown sediments, in this area they are described as being mostly brown, fine sandy silt and silty clay, with occasional gravel inclusions. They may occur interbedded within the gravels.

The overall lithology of the drift is expected to vary across the site as different amounts of the above units accumulated. The exact composition of the drift, both with depth and lateral extent across the site is expected to be highly variable. Nevertheless it appears from local boreholes that several different drift layers in this area are consistently abundant in coarse, flint and chalk gravel material. The thickness of the drift is also believed to vary greatly across the site. This Assessment has derived a contour plot of the Chalk’s upper surface where it forms the rock head. As this varies greatly across the site, so the thickness of drift is expected to vary. In places, through the centre of the site for example, the drift is likely to exceed 10 metres in thickness, while around the northern and southern boundaries where the rockhead is closer to the surface, it may be much less, at only 2 or 3 metres in thickness.

The Upper Chalk at its full extent has a thickness of 330 metres in this region. The top few metres of the Chalk have often been subjected to weathering and some erosion prior to its burial beneath the Lambeth Group. It is common to find this section of the Chalk to have decayed to form a Chalk clay known as Putty Chalk. Firm blocks of Chalk are suspended within a damp or wet white marly clay. With depth the clay content reduces and the Chalk becomes more firm until un-weathered hard Chalk is reached.

The Upper Chalk is a clean white limestone with clear joints and fractures represented by the Tarrant Chalk Formation directly beneath the Reading Formation. The Tarrant Chalk Formation is described in local borehole logs as a soft white chalk with relatively widely spaced but large flint seams. This horizon has a maximum thickness of 40 metres in the region.

6 Structure

The strata beneath the local area have experienced minor tectonic deformation since their deposition, nevertheless there has been structural alteration of the strata. The resulting structural features have a significant influence on the presence and movement of groundwater regionally with direct relevance to the ground beneath the PWL site. The strata were folded due to the north-west directional pressure caused by the African continental plate pushing into the European continental plate. There are secondary compressional features caused by the North Atlantic Spreading ridge (Jones & Robins, 1999) which combined with the aforementioned compression has resulted in the gentle folding of rocks across the south of England and southern Wales.

The largest structural influence in the catchment on the Havant Springs is the Chichester Syncline (Figure 10). This has been referenced by ENTEC (2006) and Jones & Robins (1999), as having a significant influence on groundwater flow in the catchment. The syncline dips gently at about 2-3° on its southerly limb, but is much more steeply dipping on the northern limb. This large, but gentle fold, forces groundwater largely beneath it or towards the east, rather than the general path southerly towards the coast.

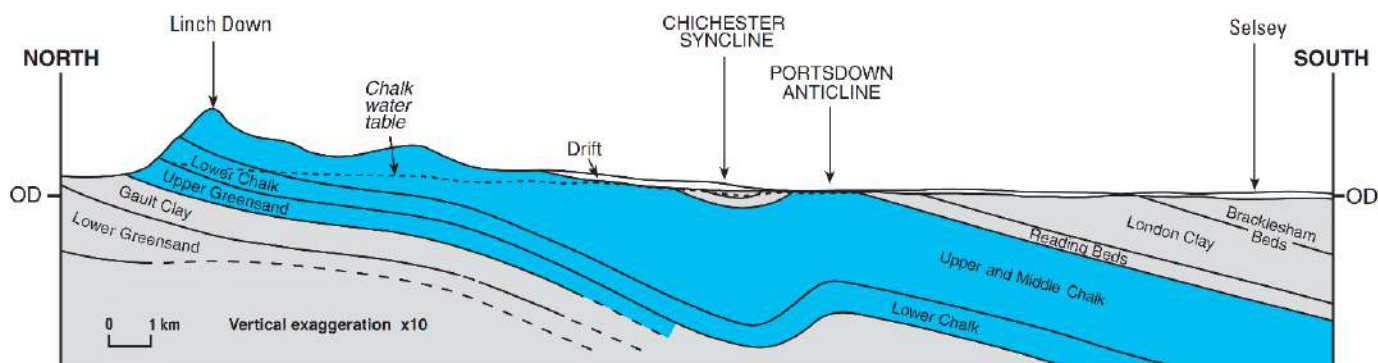


Figure 10: South Downs & Chichester Cross Section (Jones & Robins 1999)

A small proportion flows upwards, and issues as springs onto the Palaeogene infill within the syncline. Groundwater issues at ground surface at discrete discharge points along the syncline, with Havant – Bedhampton Springs as one, along with Fishbourne Springs further along the coast, on the southern side of this feature (Figure 12). The Havant-Bedhampton issue has historically been thought to emerge at a culmination of the Chichester Syncline at this point (Jones & Robins, 1999).

By conducting geophysical surveying of the site this Assessment has found that the emergence of springs across the Havant site is due to the proximity of Chalk to ground level, however this is fault controlled and not simply the result of just folding, see Hydrogeological Conceptual Model Section 10.

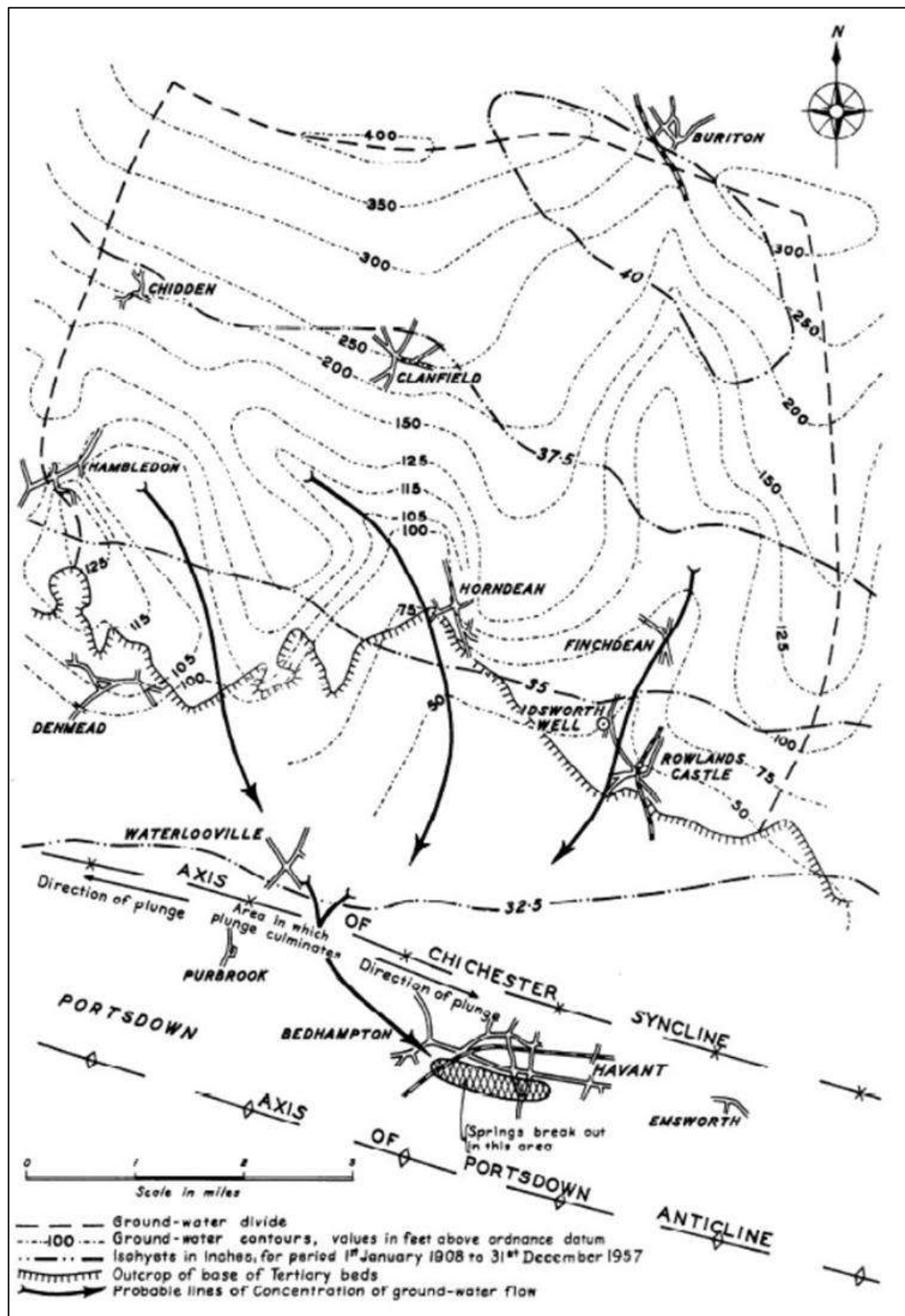


Figure 11: Havant & Bedhampton Springs Groundwater catchment (Day, 1964)

7 Hydrology and Hydrogeology

7.1 Hydrology

Havant Springs emerge from Chalk present at a depth of up to 10 metres below ground level. They originally flowed at ground level via a number of streams into Langstone Harbour. Brockhampton Stream runs along the western boundary of the site, and still flows out to the Harbour.

Groundwater and surface water are hydraulically connected in this area. Chalk groundwater is driven upwards by artesian pressure within the aquifer, as it rises there will be some contribution to shallow groundwater which in turn is directly or indirectly linked to surface waters. On site, the springs are housed in collection chambers just below ground surface, and are enclosed to avoid pollution from ground level. Spring flow is directed to the pumping station via a covered culvert which was formerly an open channel.

There are two man-made ponds on the Headquarters site, created originally for water storage for the steam engines on site rather than occurring naturally. These appear to have self-sealed over time, so are not in direct hydraulic continuity with groundwater on the site. The Brockhampton Stream has no hydraulic link with the ponds and is thought to be isolated from groundwater within the clay bunded section of the site.

7.2 Hydrogeology

Regional groundwater flow is southerly, towards Langstone Harbour, and the Solent. Groundwater flow on site is also towards the south.

The groundwater catchment for the springs is separate to the emergence zone due to the regional geological structure. Rainfall recharge enters the Chalk north of the Chichester Syncline where it outcrops at ground level. Diffuse recharge occurs widely across the area as well as rapid direct recharge which occurs where swallow holes create pathways from ground level to the water table at depth.

Swallow holes in the vicinity of Clanfield and Horndean lead the Chalk to be karstic in nature. The catchment of the springs (Atkinson & Smith, 1974) appears to extend from Hambleton in the west, to just west of Rowlands Castle in the east. Its northern extent reaches almost as far as Buriton (Figure 12). The swallow holes have had several tracer tests carried out on them (Atkinson & Smith, 1974 and Barton et. al., 1996), confirming that they act as fast track conduits from ground surface on the South Downs, directly to the springs at Havant and Bedhampton Springs.

The elevation of the recharge area results in a hydrostatic head which drives groundwater beneath the Chichester Syncline. The proximity of the Chalk to ground level in the Havant area has long been assumed to be the reason why springs rise on the southern side of the Chichester Syncline. Flow of groundwater from the north is assumed to be via a network of preferential joints, fractures and fissures probably reflecting and exploiting weaknesses resulting from the tectonic deformation affecting the strata. Even under drought conditions, the output from the springs at Havant has never dropped below 53 Ml/d, showing their resilience and the magnitude of groundwater flow.

Beneath the PWL Havant site there is a layer of drift consisting of sands, gravels, silts and clays which are water bearing. Most water in these sediments originates locally from rainfall although a component will originate from the underlying Chalk where springs force water upwards through the base of the drift. The hydraulic gradient is thus upwards from the Chalk thereby limiting the ingress of potentially inferior quality shallow groundwater into the Chalk.

Havant Springs site had a clay bund installed around them in 1886 which has a width of around 3 feet and a depth of between 10 and 30 feet, see Figure 2. The bund continues all the way around the main spring collection area and is reported to key into either Clay or Chalk at varying depths (Thomson, 1897). The bund was installed in response to the springs being located close to a densely inhabited area where cesspits were still widely in use. The puddle clay barrier was put in place to prevent inflow of shallow contaminants from these pits, however water quality did not improve following on from this work, neither was it particularly poor in the outset.

The bund has been altered since its installation, in the process of service provision on the site, where it has been knowingly breached. It is unknown if this has affected the springs or not. The barrier originally prevented the lateral movement of shallow groundwater across the site and contained the upwelling Chalk groundwater. If the structure remains sufficiently intact it should continue to provide the same protection and hydraulic separation.

It is known that heavy rainfall over the recharge area of the South Downs supplying the springs caused high turbidity levels in the springs within a few days; tracer tests at swallow holes at Hazelton Wood on the South Downs confirmed this fast connection (Atkinson & Smith, 1974). This was also the case during the construction of the A3(M) where discharge of water used on the construction sites around Horndean and Clanfield to swallow holes in the north of the catchment caused water quality problems at Havant within hours (Atkinson & Smith, 1974). These issues are catchment based rather than site based, and are difficult to manage as they reflect events and actions occurring a distance away from the springs which are out of the control of PWL.

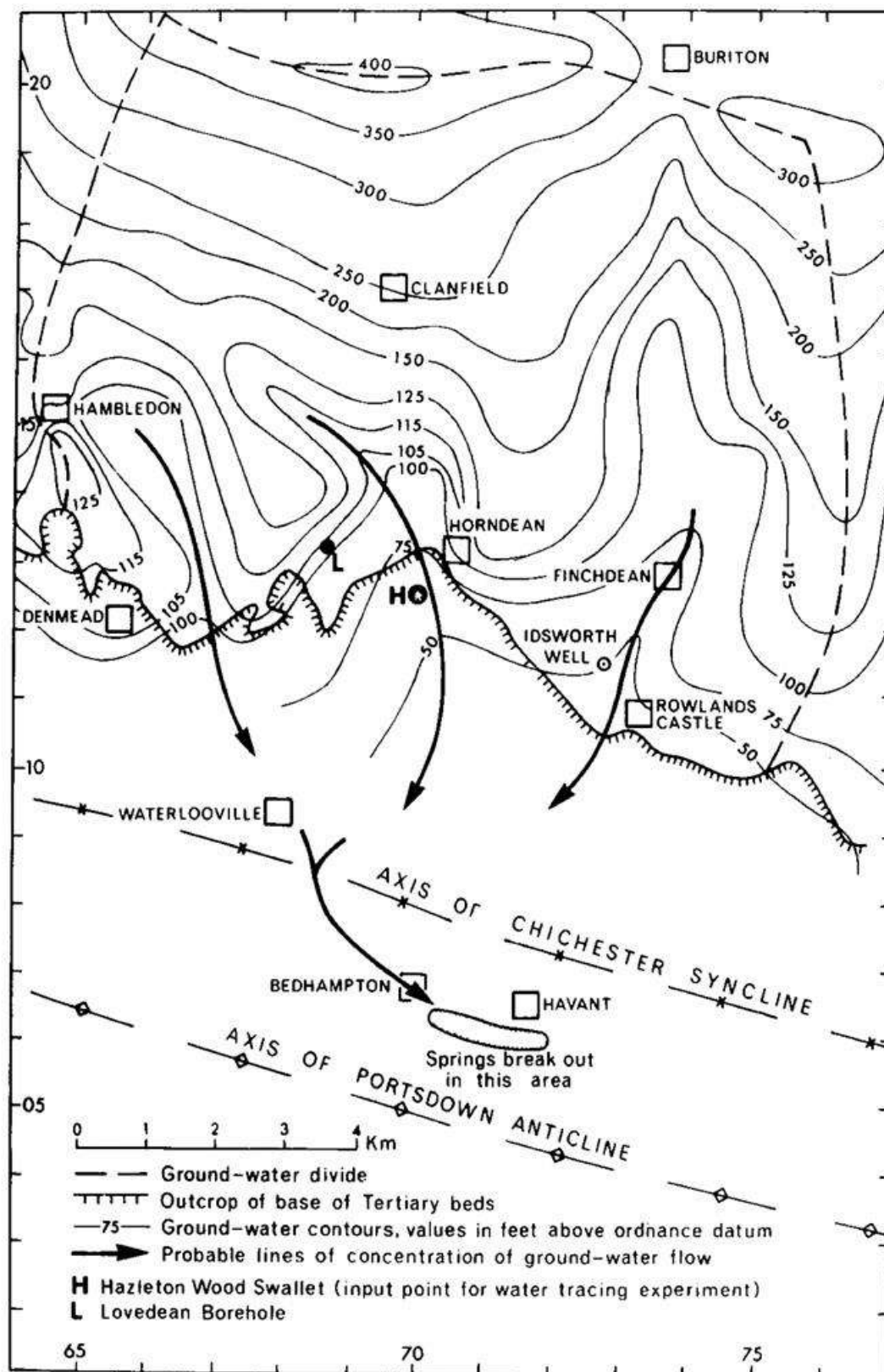


Figure 12: Groundwater Catchment & Flow Paths (Atkinson & Smith, 1974)

8 Geophysics

8.1 Introduction

As a result of the literature review undertaken by B. A. Hydro Solutions Ltd, it was concluded that there was little geological data available for the Portsmouth Water Headquarters site. One site investigation was carried out, exploring the site to a maximum depth of up to 5 metres. This only extended part way into the thin layer of drift, overlying the Chalk beneath. The depth of the Chalk was thought to vary over the site, as a review of off-site boreholes available, indicated that it was a considerable depth to the south and much closer to the ground surface in the north, contrary to the geological setting widely reported.

The deeper geology on the site has not been investigated or recorded previously. Further site investigation was proposed, but the method employed for this purpose was closely examined first. Drilling small diameter boreholes was suggested to probe into the site below ground, but had the potential for pollution of the springs via pathways drilled into the source aquifer. Also, due to the artesian nature of the Chalk, it was determined that drilling of boreholes could cause problems when it came to backfilling and sealing them, and could potentially be another mechanism by which pollution could be introduced to the Chalk.

Geophysical methods were examined as an alternative to physical drilling on the site, as a non-invasive method of “seeing” into the sub-surface. Electrical Resistivity was chosen as the best method for the site, in order to define the Chalk upper surface, and also delineate any other geological boundaries, structures and other objects on the site.

8.2 Electrical Resistivity

Resistivity works by setting out a straight line of electrodes connected via cables to a central recording system, and battery source. A variable energy input is selected, and injected into the ground via the electrodes, with a set of four or more electrodes in play each time current is injected, two injecting, and two or more receiving. Generally, the depth achievable is approximately one fifth of the spacing between the first and last electrode in the line. i.e. if the line is 100m long, then resistivity down to a maximum depth of around 20m is possible.

The combined electrical resistance of the different materials beneath the line and between the electrodes is measured when an electrical circuit is created through the ground. Ground with a greater abundance of free ions, and particularly saturated ground, has a lower electrical resistance than dry ground with a relative absence of free ions. The relative difference between horizons can be distinguished thereby

allowing this technique to map geological boundaries and geological structures within the ground.

8.3 Survey Design

B. A. Hydro Solutions Ltd. identified early in the production of the Hydrogeological Risk Assessment that there was a lack of geological information relating to the site and the surrounding area. It was necessary for the geophysical survey to cover as much of the site as possible whilst striving to provide a good level of detail consistently across the site. There were no clear areas where more or less information was known about the underlying geological sequence or structure.

B. A. Hydro Solutions Ltd. devised a network of geophysical transects that crossed the site and cut through each other. The spatial distribution was important to maximise the coverage, however, equally important was for the transects to cross each other so that information collected from one could be spatially linked directly or indirectly to all others. A total of six transects were proposed, all designed around the main constraints on site including buildings, walls, buried tanks, ponds, streams, culverts, power cables and vegetation.

Figure 13 illustrates the six profiles as completed by the onsite surveying team between the 18th and 22nd July 2014. The lines consist of three orientated north-south, two with an east-west alignment and one with a line from south-west to north-east. All but one of the lines crossed at least two other lines, the most northern east-west line crossing only one other line. The length of each survey line was deliberately sought to be as long as possible in order to maximise the depth to which the survey could 'see' into the ground. This was fortuitous as in the southern part of the site the Chalk was found to be present at depths of more than 30 metres below ground level. Table 2 lists the transect lengths and electrode spacings used.

Transect No. & Survey Type	Transect Start National Grid Reference	Transect Start National Grid Reference	Length of transect (metres)	Electrode spacing (metres)
1 – Dipole-Dipole	SU 71317 06299	SU710120 6124	315	5
1 – Schlumberger Reciprocal	SU 71317 06299	SU 71012 06124	315	5
2 – Dipole-Dipole	SU 71257 06243	SU 71272 06377	135	5
2 – Schlumberger Reciprocal	SU 71257 06243	SU 71272 06377	135	5
3 – Dipole-Dipole	SU 71058 06102	SU 71066 06415	315	5
3 – Schlumberger Reciprocal	SU 71058 06102	SU 71066 06415	315	5
4 – Dipole-Dipole	SU 71073 06286	SU 71346 06316	275	5
4 – Schlumberger Reciprocal	SU 71052 06285	SU 71346 06316	295	5
5 – Dipole-Dipole	SU 71161 06308	SU 71112 06098	213	3
5 – Schlumberger Reciprocal	SU 71161 06308	SU 71112 06098	213	3
6 – Dipole-Dipole	SU 71048 06421	SU 71188 06375	142	2
6 – Schlumberger Reciprocal	SU 71048 06421	SU 71188 06375	142	2

Table 2: Resistivity transect survey line details

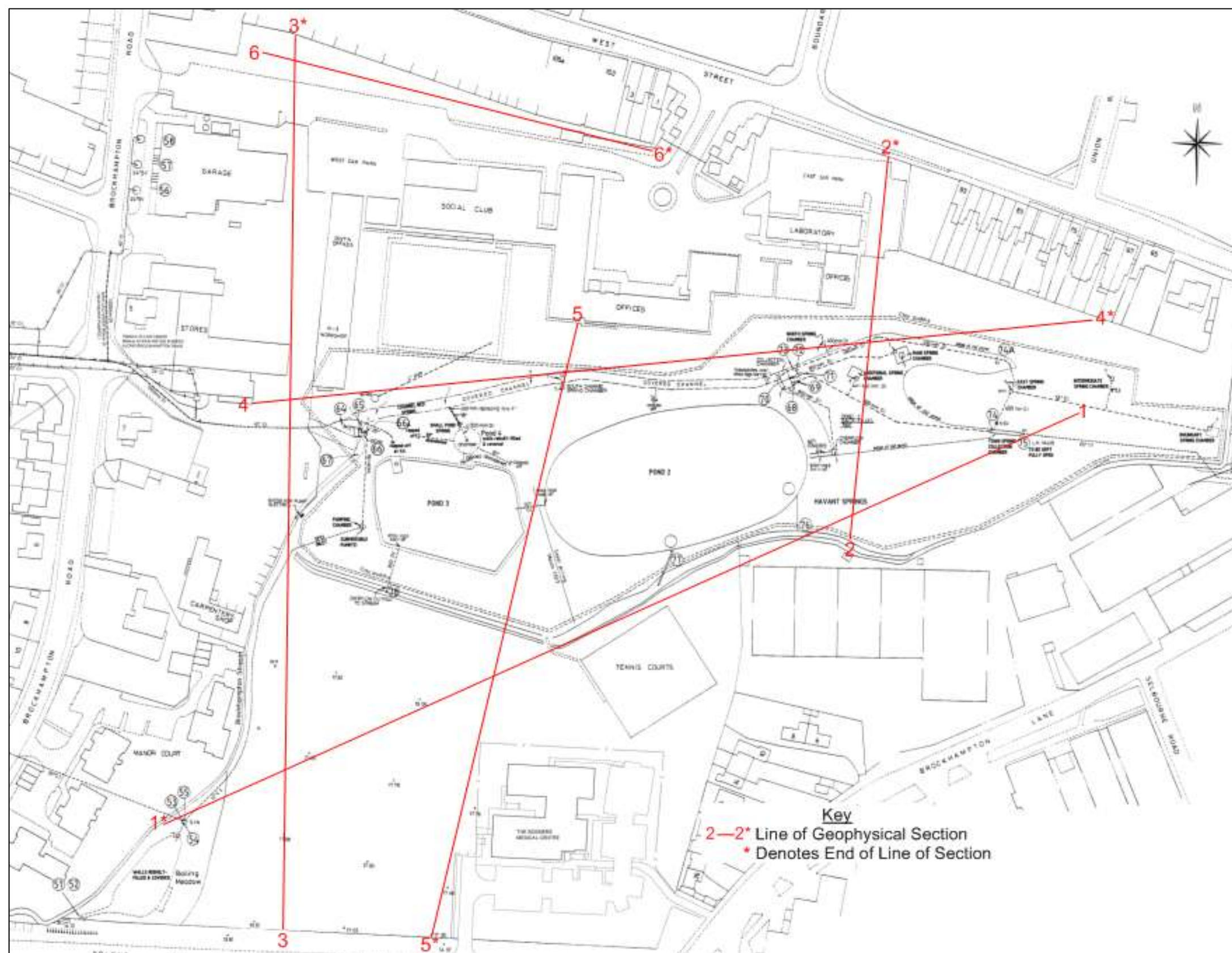


Figure 13: Geophysical resistivity transects

8.4 Methodology

The electrical resistivity transects were agreed with Portsmouth Water and a pre survey site visit was completed in order to confirm the proposed lines could be practically surveyed. B. A. Hydro Solutions Ltd. organised the hire of external equipment to supplement their in-house geophysical survey tools. All survey equipment was mobilised to site on the 18th July 2014, and surveying commenced on the same day.

Portsmouth Water completed work ahead of the survey to prepare the site for the ground investigation work, crucially this included cutting back vegetation and piloting holes through the tarmacadam covered areas to the front and sides of the head office and laboratory buildings. B. A. Hydro Solutions Ltd. enlarged and deepened the drilled holes to a depth of around 0.45 metres and to a diameter of 0.012 metres.

Each transect was set up individually with up to 72 electrodes, depending on the length of the line the spacing between the electrodes varied from 1.5 metres up to 5 metres. Every effort was made to limit topographic changes along the line of each survey by carefully laying out the electrodes. Equally the survey lines were made as straight as practically possible over their full lengths.

The electrical resistance between the electrodes and the ground, was measured on each electrode once driven into the ground, connected to the communication cable and back to the control box. Most were found to make a very good electrical contact with the ground, any with high resistances were driven further into the ground and/or the surrounding ground was soaked with a saline solution. During the course of the survey none of the data was lost due to poor contact between any of the electrodes and the ground.

Once all electrodes were confirmed as forming a good connection to the ground, the surveys were commenced. Initially a Schlumberger Reciprocal survey was completed on each transect, this typically took the computer control system up to two hours to complete. During this time an electrical circuit was being repeatedly made by working through around 2,000 different electrode combinations/configurations. Once complete, a Dipole-Dipole survey was set-up and completed on each transect, again taking between one and two hours to complete.

The two surveys were completed on all six transects, successfully generating between 4,000 and 6,000 measurements of the grounds' electrical resistance along each survey line. The data was checked by the survey team after each survey in case there was a need to repeat the test before dismantling the electrode array. This was never found to be necessary as the data in all instances was found to provide a good insight into the subsurface.

At the end of each day the electrodes were either, collected together and stored until the survey the following day, or installation commenced on the next survey line in readiness for the following day. The surveys were completed using one of two high Amp-hour output batteries which once used in conjunction with an inverter generated up to 800 volts of power. Completing a minimum of two surveys each day meant the batteries were depleted to such an extent, that by the end of the day, they had to be put on a rapid charge each evening in order to be replenished sufficiently by the next day to have enough power output to complete the tests.

8.5 Survey Results

The raw data generated by the twelve electrical resistance surveys completed along the six transects is primarily apparent resistivity of the ground. The data must be processed to remove anomalous data and then modelled to derive the most likely actual electrical resistance values for the ground surveyed. B. A. Hydro Solutions Ltd. carefully processed all the data logging the data removed, the different filters used and smoothing effects applied to the data before the modelling was begun, see Appendix B.

The raw data was processed using Prosys II software (Version 03.07.04), the resulting data files were converted and exported into a format that could be used in Res2din software. The latter is used to produce a model of the ground surveyed, which attempts to replicate the measured apparent electrical resistance values. After completing a series of iterations the model arrives at a representation of the ground conditions most likely to be present which would produce the same apparent resistivity values as those measured.

The fit of the model to actual data is measured as a percentage difference between the measured and predicted. The target is normally to achieve less than a 5% error, in most instances this was far exceeded although for some profiles achieving a convergence between the model and reality was not possible with this level of accuracy. Res2din calculates the sensitivity of the model for each of the cells it generates based on the data.

For each transect the Schlumberger Reciprocal data, the Dipole-Dipole data and the combined Schlumberger Reciprocal and Dipole-Dipole data has been modelled. For each, a sensitivity analysis has been completed, these are considered before the model results are discussed. The Res2din model plots the measured data points across a grid of cells, each representing the lateral and vertical position of the measurements along the line of the survey section. Cells normally represent one data point although the cell density can be doubled so two cells represent each point. Within each cell the model calculates the theoretical electrical resistance of the ground at four equally spaced nodal points.

B. A. Hydro Solutions Ltd. modelled all the data with the double density of cells, the model thus calculated the theoretical electrical resistance of the ground at eight times the number of data points actually measured. The density of calculation points illustrated in the sensitivity plots thus reflects the significantly larger number of computational points compared to the actual number of measured points.

The following plots illustrate that the models are most sensitive and thus more accurate towards their centres, and generally the shallower the models look into the subsurface, the more sensitive they are. The model of the Schlumberger Reciprocal data becomes less sensitive at a shallower depth than the model of the Dipole-Dipole data. When the two data sets are combined for each profile the most sensitive and thus most reliable areas of the model extend deeper and further from the centre point of the profile. Where electrodes had to be omitted during the surveys, due to obstacles or unfavourable ground conditions, there is then a loss of measurement points in the data set which results in areas of the model becoming less sensitive, this can be seen in profiles three and six.

The sensitivity analysis shows that all the models have a relatively similar level of sensitivity and thus reliability. The plots are in line with expectations and thus further confirm the field measurements were collected effectively and that the data can be considered reliable. The sensitivity plots have been used to inform this Assessment as to where measurements can be drawn from the electrical resistivity modelling outputs in order to predict the depth to Chalk. These measurements have been restricted to areas where the model sensitivities have been highest; measurements were not taken from the profiles where there was a low level of sensitivity.

9 Modelling Results

The results from the modelling reflect the most likely distribution of high to low electrically resistant ground. It is essential to note that the plots do not illustrate strata or different rock types, rather the model outputs illustrate predicted changes in the electrical resistance of the ground which may be interpreted as geological, structural and hydrogeological features.

The outputs from the models are illustrated in this section with the results from the Schlumberger Reciprocal, Dipole-Dipole and the combined Schlumberger Reciprocal and Dipole-Dipole plotted above each other for quick visual comparison. All model outputs, except number 6, indicate the presence of ground with a high electrical resistance at depths ranging from 8 to almost 30 metres below ground level. In all plots this feature(s) shows as a dark red to purple horizon or block of ground.

The ground with a high electrical resistance has been interpreted as Chalk and thus the change in electrical resistance illustrates the upper surface of the Chalk. There are areas of high to medium resistance which are also likely to represent the Chalk although there is not such a clear boundary between low and high resistance. Where there is not a clear change in resistance this Assessment suggests it is due to the Chalk being weathered or more fractured resulting in a higher water content and thus a gradational change in resistance.

Profile 1 has a central low resistance anomaly which coincides with a reported line of sheet piling and the Clay bund. It is thus likely the decay of the former iron sheet pipes and the higher presence of free ions associated with the clay of the bund has resulted in the feature seen. The inferred upper surface of the Chalk in profile 1 clearly dips from the south west towards the north east. Beyond the low resistance anomaly the Chalk is not as obvious although there is still a presence of medium to high resistance ground, and at a shallower depth than in the south west.

Profile 2 indicates there to be a shallow horizon of low resistance ground extending beneath the car park next to the laboratories and towards the south. The combined Schlumberger Reciprocal and Dipole-Dipole plot shows the presence of Chalk at a shallower depth beneath the car park below the low resistance layer. To the south the Chalk is also present but possibly at a shallower depth. The combined plot also illustrates boundary effects of the model due to less reliable, less sensitive data along the margins which introduces features in the plot that almost certainly do not exist.

All three plots of Profile 3 contribute to the understanding of the geological sequence, structure and conditions present, no individual plot provides all the answers. This shows clearly why it is important to consider the data sets separately as well as combined as otherwise some features may be missed. The Schlumberger Reciprocal most clearly shows the Chalk along the southern section of the profile. The Dipole-Dipole plot shows there is probably high resistance ground at a shallow depth to the

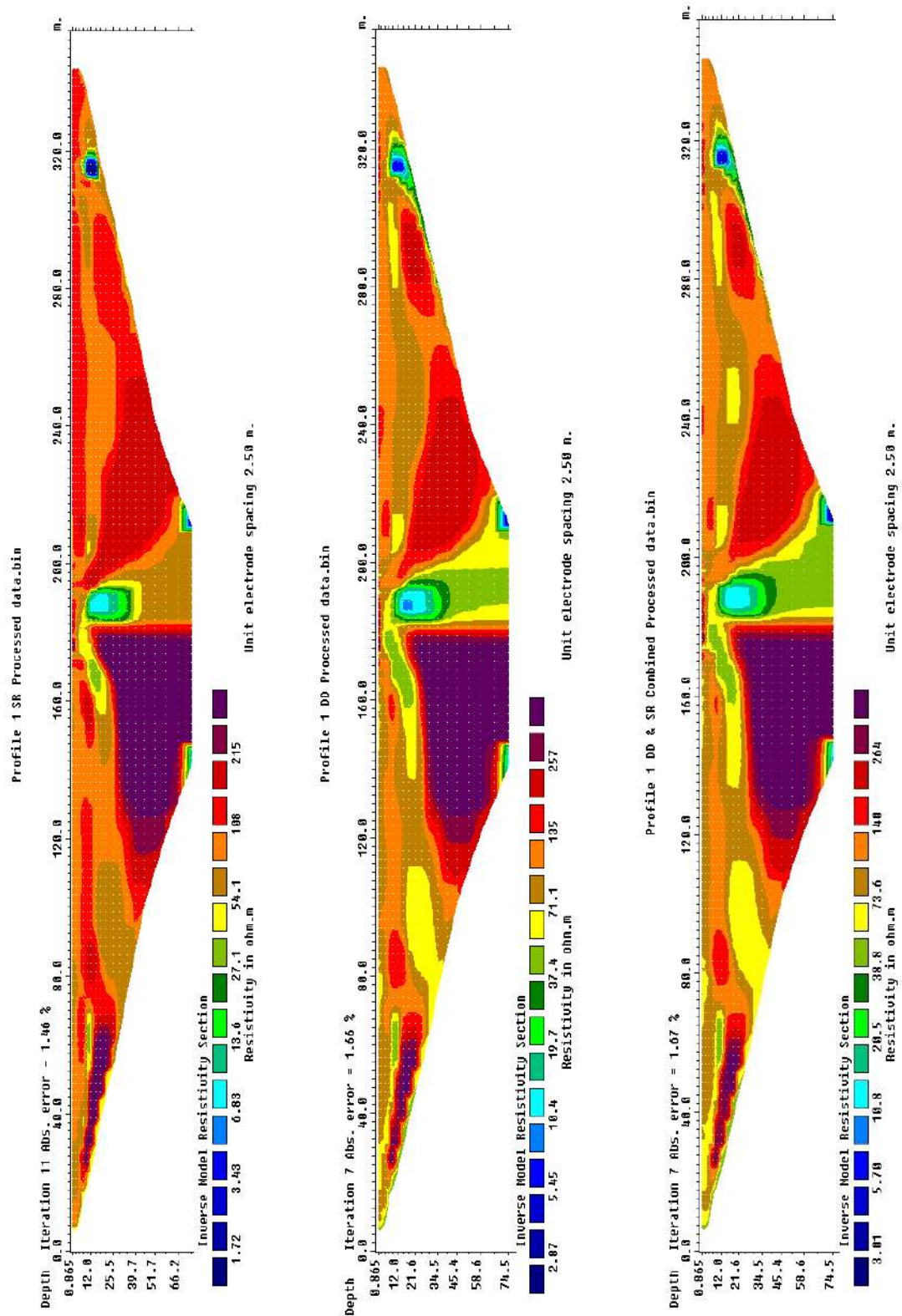


Figure 14: Electrical resistivity transect Profile 1

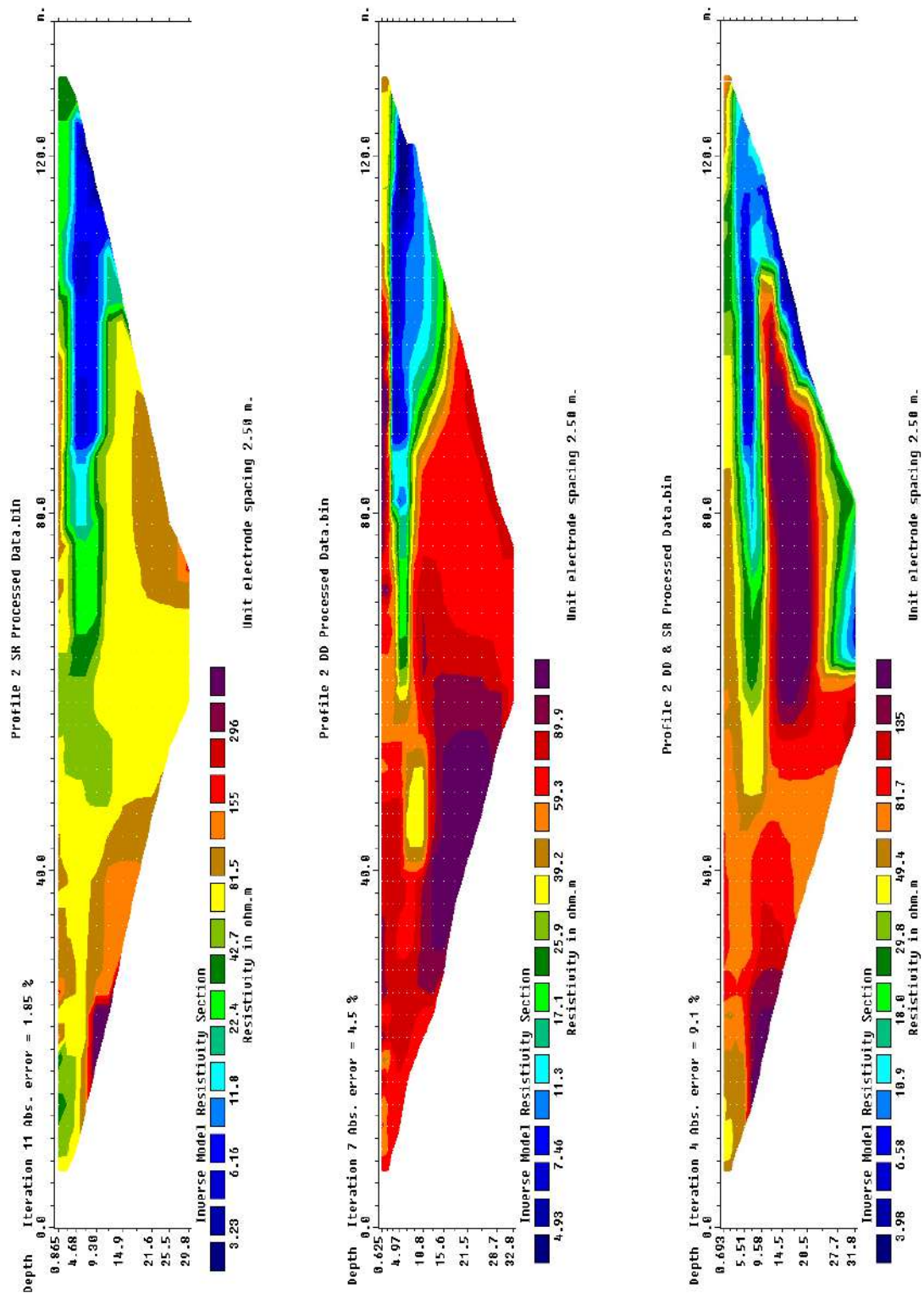


Figure 15: Electrical resistivity transect Profile 2

North, although there are a lot of interference and low resistance areas. This is hinted at by the Schlumberger Reciprocal data. Combined, the two data sets show there is a high resistance sub straight to the north and by extrapolating between two high resistance hot spots (shown in red) the top of the Chalk in this area may be inferred.

The three plots produced from the data collected along the line Profile 4 show high resistance islands along the line which are inferred as the Chalk. Low resistance points may represent vertical pathways of groundwater flow linking through to the springs. The combined plot suggests there may be blocks of high resistance Chalk set in more fractured ground with groundwater present and moving through joints and fractures and possibly with softer, weathered or more fractured ground between blocks of firm Chalk.

The Schlumberger Reciprocal plot from Profile 5 suggests the Chalk is present at a shallower depth in the north compared to the south. There is a shallow low resistance anomaly in the centre of the Schlumberger Reciprocal and the Dipole-Dipole plot which coincides with the ponds present on site. In plots, particularly the Dipole-Dipole plot, there are pockets of low resistance ground which may represent saturated pockets of sand and/or gravel. This is quite possible as lenses of sands and gravels have been documented on the shallow ground, if this is the case then profile 5 illustrates how irregular and laterally variable they can be.

The plots generated from data collected along the line of Profile 6 show there to be a shallow zone of high resistance over a layer of low resistance which may then rest on an increasingly resistant layer at depth. This sequence has been interpreted as the shallow ground being dry, possibly made ground resting on increasingly saturated drift deposits below. At a depth of ten or more metres below ground there is an electrical resistance boundary which is inferred to be the top of the Chalk. The drift appears to be more consistently saturated and possibly more sand and gravel dominated in this part of the site.

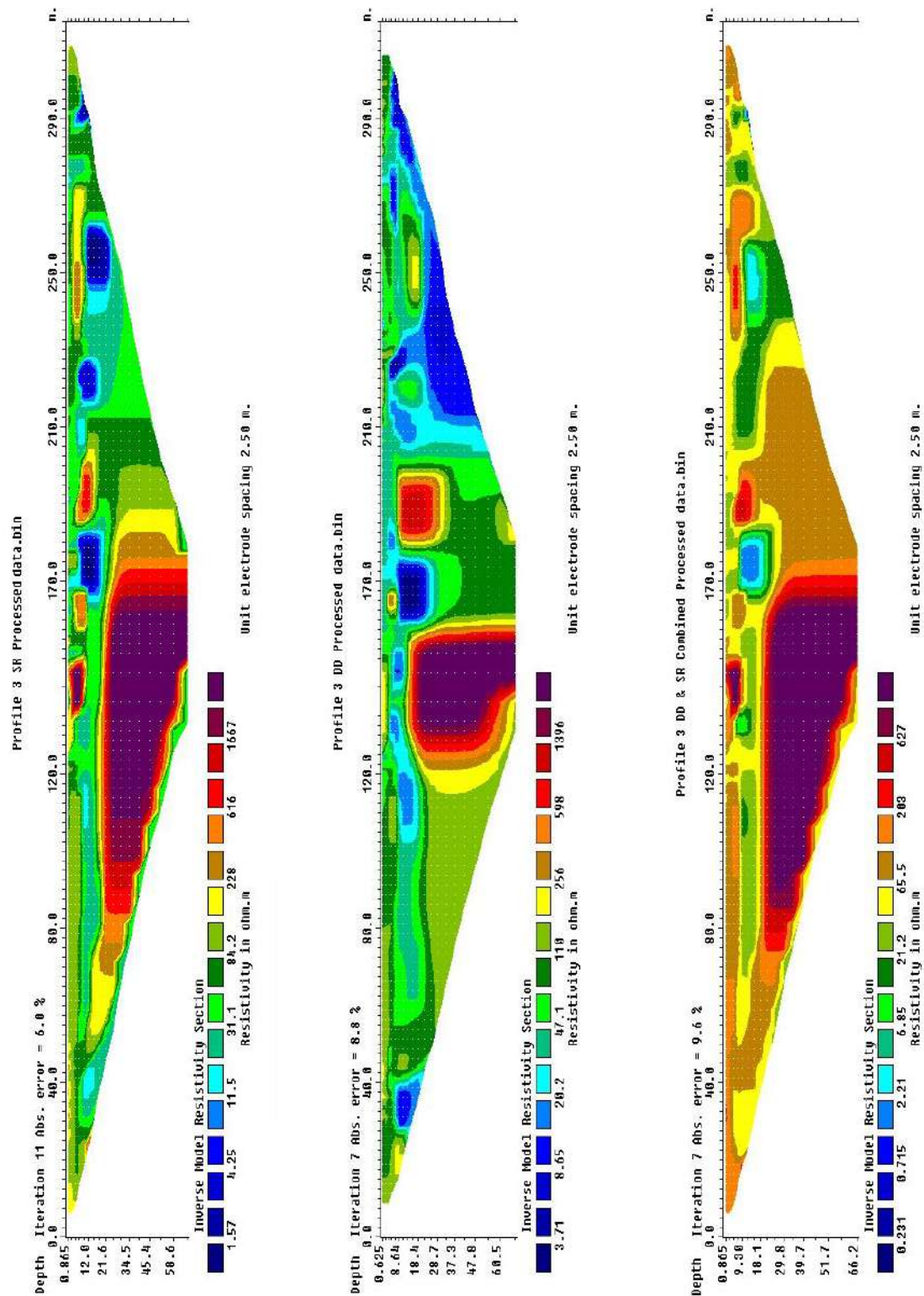


Figure 16: Electrical resistivity transect Profile 3

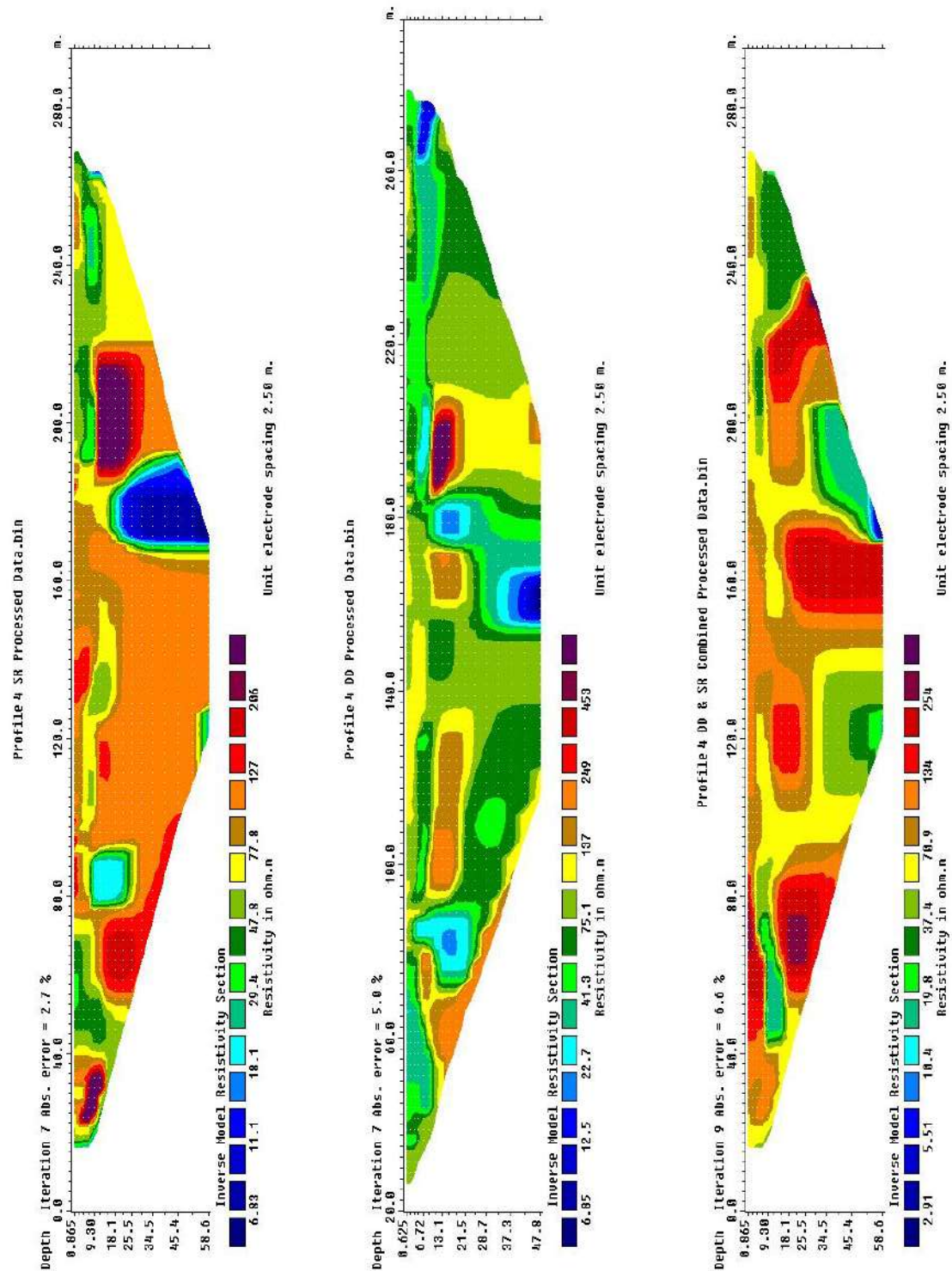


Figure 17: Electrical resistivity transect Profile 4

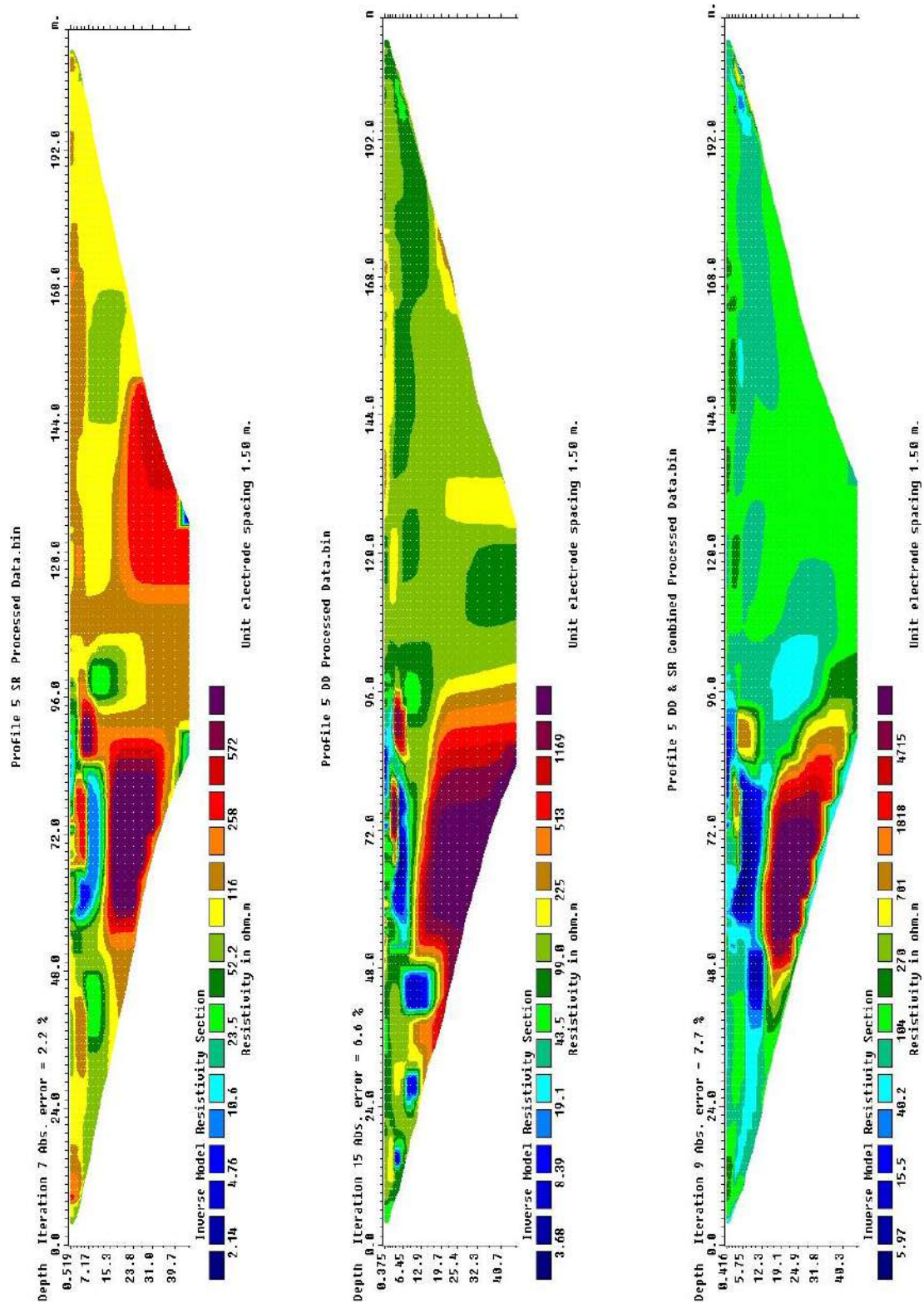


Figure 18: Electrical resistivity transect Profile 5

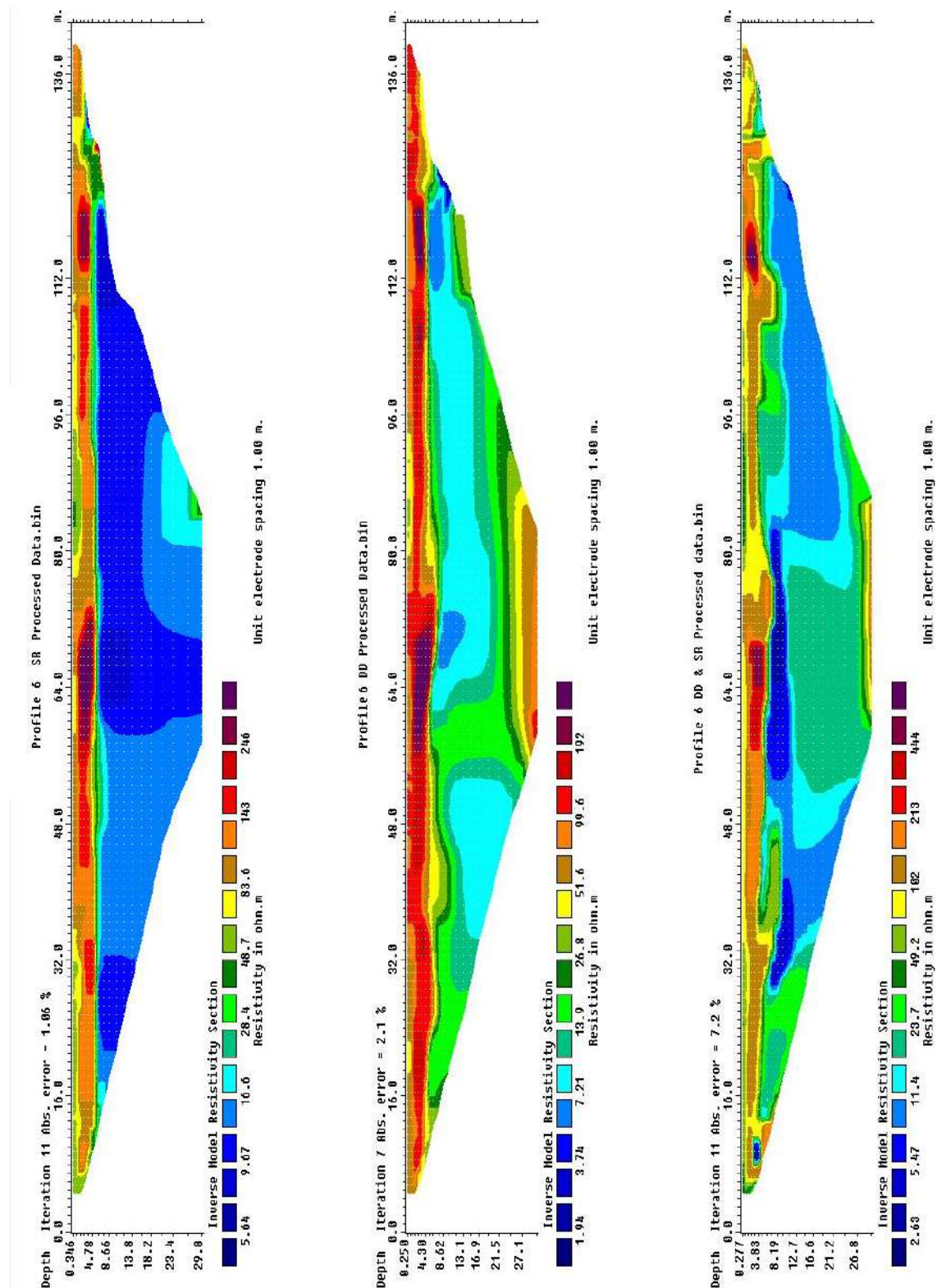


Figure 19: Electrical resistivity transect Profile 6

10 Hydrogeological Conceptual Model

As part of the risk assessment, a site conceptual model was required to be developed to understand the groundwater flow mechanisms at site. Understanding how groundwater flows to and emerges at site, allows assessment of risk factors posed by the proposed redevelopment of the site along with continuation of activities already undertaken in the vicinity of the spring.

10.1 Regional Conceptual Model

In the paper by Thomson (1897), there is a cross-section drawn through Havant, which gives an indication of the geological structure in the area, and how it might influence groundwater. This is illustrated below in Figure 20. This shows the Chalk at depth, covered by the Lower London Tertiaries to the north, and emerging at ground surface close to where the Portsmouth Headquarters are now, near West Street. No specific mechanism for groundwater flow is mentioned in the paper, but it looks to connect the emerging Chalk strata due to the Chichester Syncline to the springs close-by.

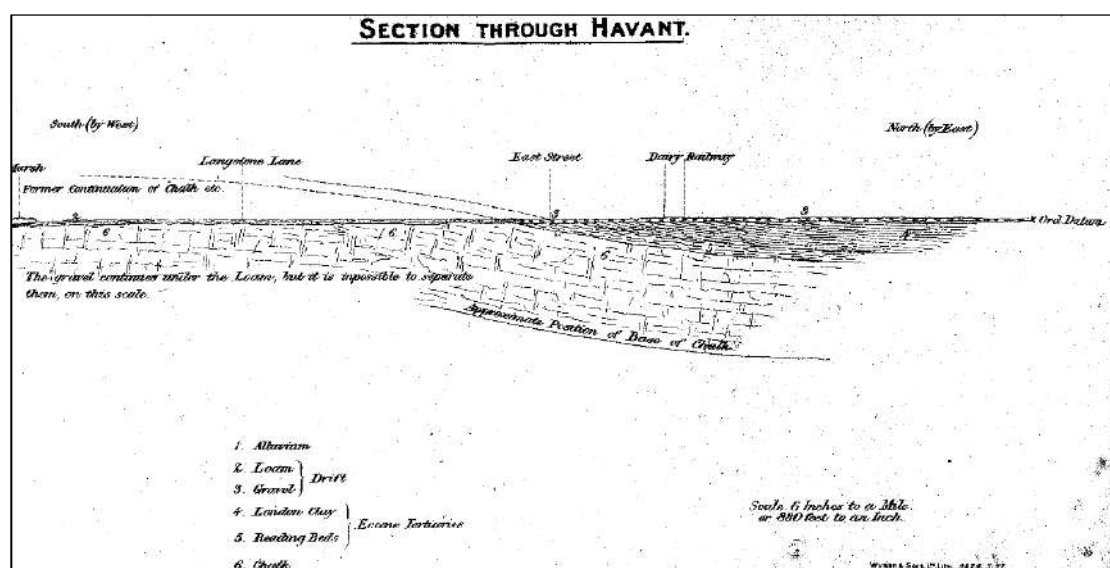


Figure 20: Cross-section through Havant – PWL site (Thomson, 1897)

The current regional conceptual model attributes the existence of Havant Springs to the Chichester Syncline structure, where groundwater from the South Downs is prevented from flowing south towards the Solent, but is forced to flow towards the east, towards the River Arun (ENTEC, 2006) and Fishbourne Springs, along the trend of synclinal structure (See Figure 12). The Havant and Bedhampton Springs appear to issue at a break or “culmination” in the Chichester Syncline, forming a 1.5km long line of springs running E-W, with 29 springs in total issuing from this feature.

Day (1964) refers to a culmination of the axis of the Chichester Syncline in the Havant – Bedhampton area, where the Chalk has been fractured heavily due to the tectonic stresses placed on it, and the groundwater can get through this zone, and then flow south and east towards the springs issue area at the site. The springs appear to break out in a line running approximately parallel to that of the strike of the Chalk.

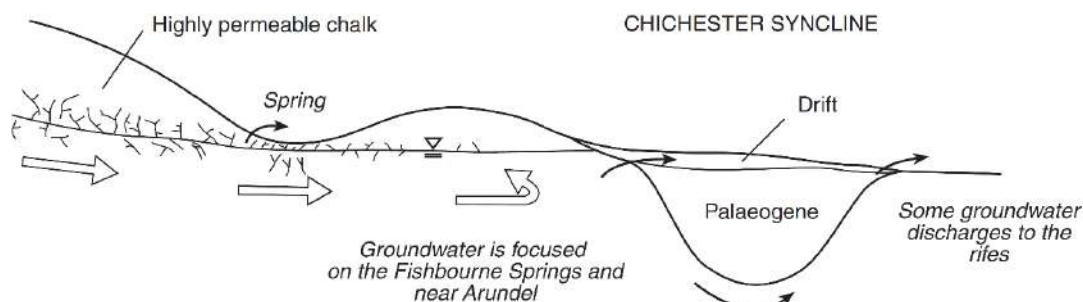


Figure 21: Chichester Syncline Influence on Groundwater (Jones & Robins, 1999)

10.2 Site Conceptual Model

Resistivity profiles across the site were surveyed in order to establish where the top of the Chalk occurred in relation to ground surface so that the proposed development could be assessed in the context of the Chalk-overburden boundary. The survey was designed based on the premise that the springs occur due to Chalk rising close to ground level. Six transects running east to west, north to south and south west to north east were completed.

The electrical resistivity survey results have been used to predict the depth to the Chalk at multiple points across the site. These measurements have been combined with measured depths to the chalk made in local boreholes and wells. The combined data set has been used to plot the upper surface of the Chalk beneath the site and the surrounding area, see

Figure 22. BAHS have established from the plot of the Chalk upper surface that the Chalk appears to be displaced by an east to west aligned fault or series of faults which results in the Chalk being present at a shallower depth beneath the north of the site relative to the southern part of the site.

The Chalk is generally dipping towards the north east in the south of the site and the north-west in the north of the site. Along a line extending roughly through the centre of the site [assumed to be the fault line or corridor of faulting] the difference in the depth to the Chalk is up to 24 metres from the north to the south side of the feature. This displacement will have resulted in the Chalk being more fractured thus allowing groundwater to move upwards more easily on the northern side of the site. Figure 23 illustrates a contour map of the Chalk's upper surface relative to ground level.

The observed displacement across an assumed fault structure explains why the springs occur along an east to west line and why there are none south of the ponds until you reach Boiling Meadow. Springs at the latter appear to be present due to the Chalk becoming increasingly shallow in the same direction. The springs are thus present due to the Chalk being almost at ground level. It is possible that there may be another fault(s) with an east to west alignment on or very close to the southern boundary which may have dropped the Chalk deeper just to the south.

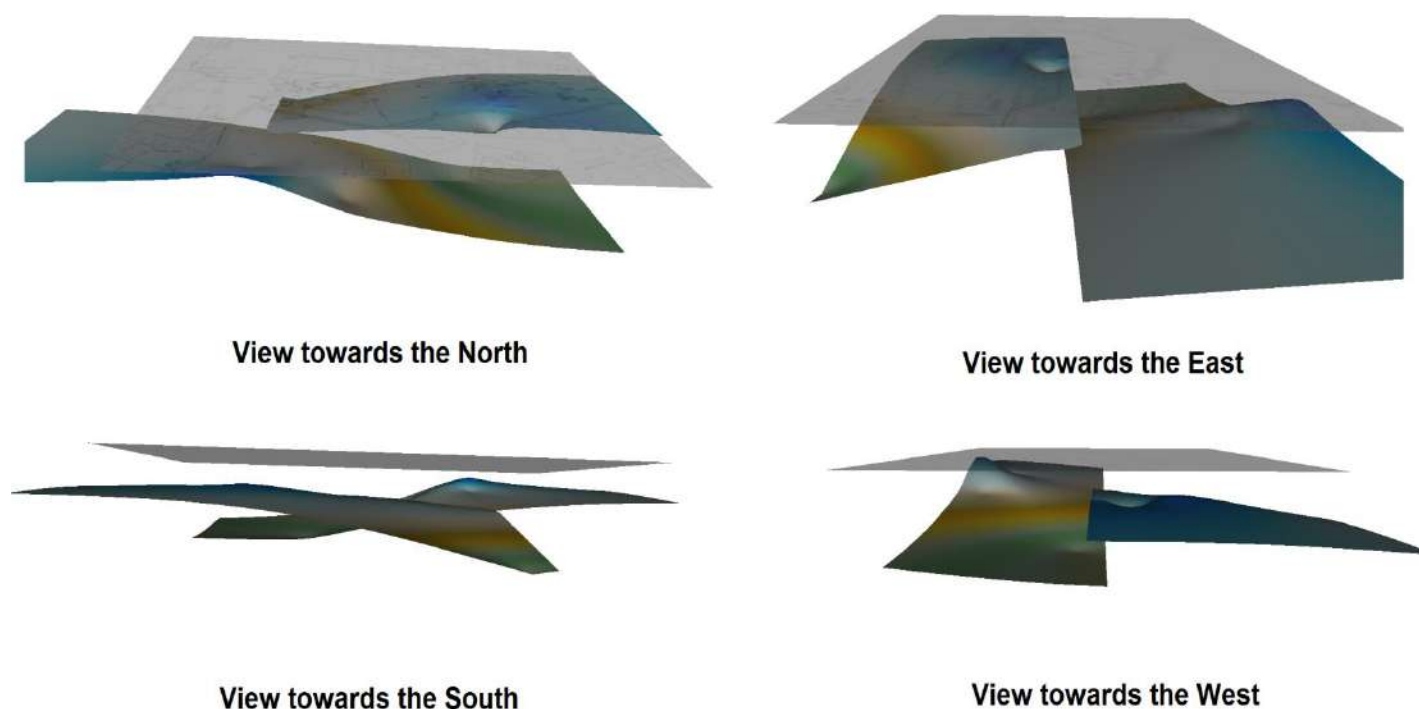


Figure 22: 3D Images of Chalk upper surface

Jones & Robins (1999) referred to a possible area of faulting within the Chichester Syncline close to the Havant and Bedhampton Springs, which allowed groundwater to emerge on the southern side of the syncline in this way. Jones and Robins' hypothesis now appears to be supported by the geophysical evidence gathered on-site.

Data from the geophysical survey and the borehole data from the local area, the proposed conceptual hydrogeological model of the site is that the springs in the centre of the site are due to, and controlled by, faulting of the Chalk below. This faulting allows groundwater to take the path of least resistance up through the Chalk and drift, and emerge at the surface. The faulting has resulted in displacement of the Chalk surface, downthrown towards the south of the site. Displacement along the fault appears to vary, with only a few metres displacement in the west, but up to around 24 metres in the centre and east of the site.

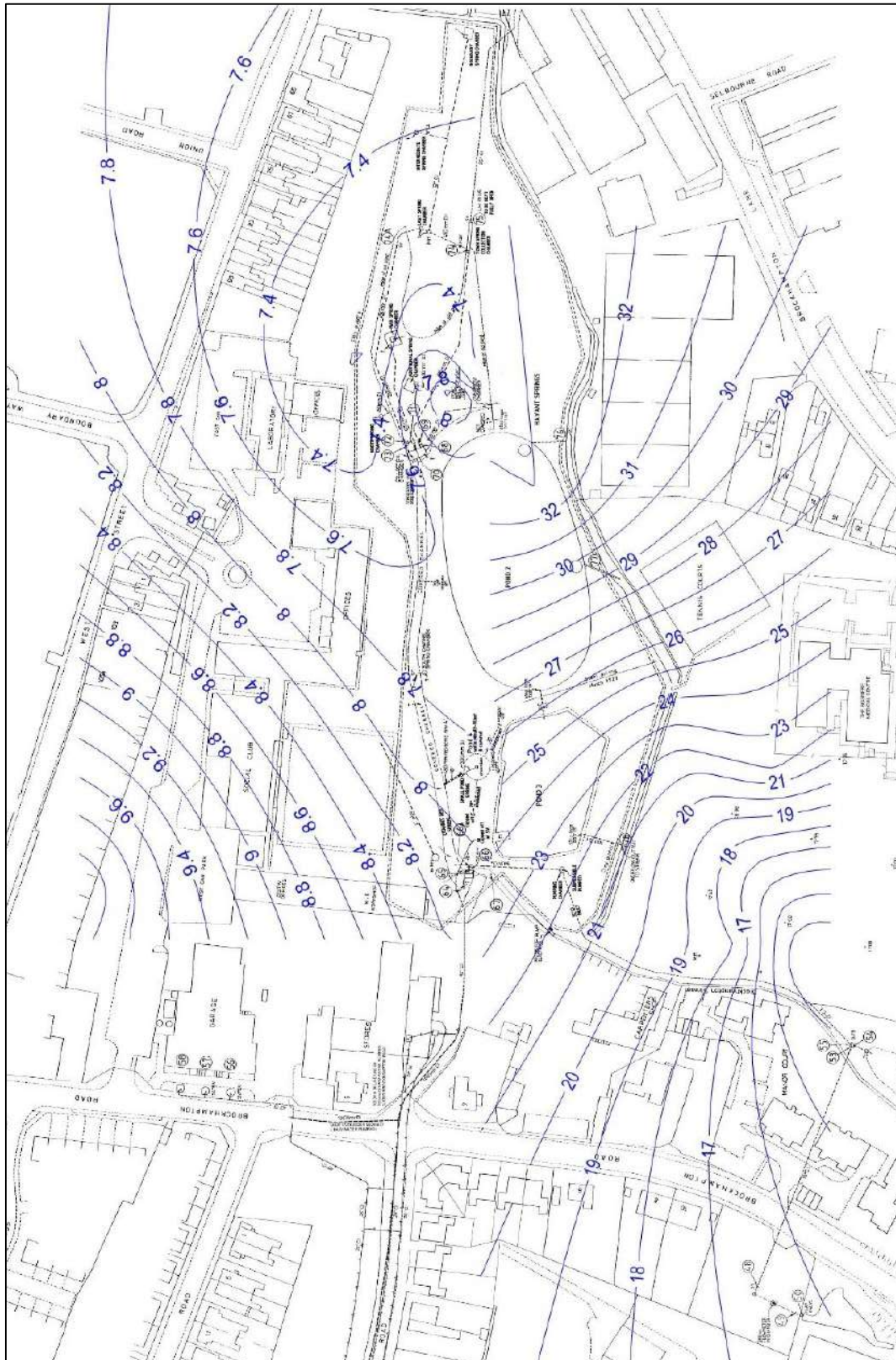


Figure 23: Contours of Chalk Upper Surface (mbgl)

Figure 24 illustrates the proposed revised hydrogeological setting of the Havant Springs. Groundwater is shown to rise from the deeper Chalk via pathways associated with the faulting, shallow groundwater recharged from rainfall is shown to circulate separately to Chalk fed groundwater as a result of the 19th Century clay bunds. A second fault zone may also occur off the edge of the figure towards the south.

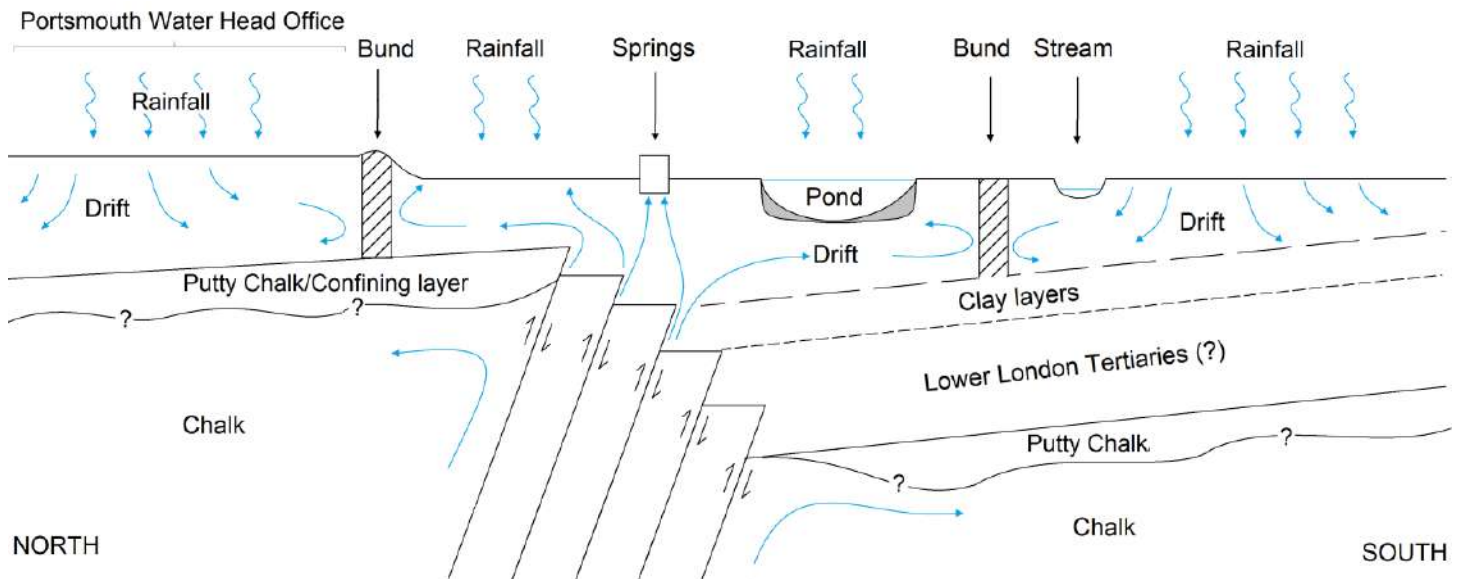


Figure 24: Hydrogeological Conceptual Model of Havant Springs

Boiling Meadows Spring(s) appear to rise due to the Chalk emerging close to ground level, they too may be fault controlled. Although not shown in the above figure the Boiling Meadow Spring(s) would be present to the right of the figure. BAHS suggest that there may be at least one more fault corridor close to the southern margin of the site running parallel to the faulting seen through the centre of the PWL site.

Faulting may be responsible for other springs roughly in line with the Havant site, and this zone may extend further east and west from the site. This cannot be confirmed without further investigation, but may explain why these springs are also present along a similar east to west trending line.

11 Impact Assessment

This section of the report addresses the potential risks posed by redeveloping the Portsmouth Water headquarters site. These risks have been listed and discussed below from highest to lowest risk. The greatest risk to the source would be during demolition of the current buildings, development of new offices elsewhere on the site, and any redevelopment of the old office site. The greatest risks are posed by piling, and during excavation for piling, building foundations, and any other intrusive work on site. Day to day activities such as dog walking, car washing, or chemical storage, after development of a site are shown to pose a relatively low risk.

11.1 Pollutant, Pathways & Receptor

There are a number of existing risks to the Havant Springs source, which have been identified in various risk assessments including a Stage 1 desk report, internal document to the Portsmouth Water Board (Portsmouth Water, 2014) and the catchment Drinking Water Safety Plan (DWSP).

Hazards identified are multiplied by the likelihood of their occurrence, to give a risk score or ranking. Risks can often be mitigated against, to reduce the severity, or likelihood of occurrence. For risks to groundwater, the following chain is referred to:

POLLUTANT → PATHWAY → RECEPTOR

A groundwater pollutant may be chemicals, bacteria or other substance that poses a threat to the receptor, which could be an aquifer or supply well. The pathway creates a link between the pollutant and receptor, and could be a well or borehole, a trench into the ground, soakaway, swale, open pit or other conduit from ground surface into the receptor.

In order to reduce risk to the receptor, either the pollutant or the pathway must be removed. If pollutants can be removed from the area (i.e. avoid storing chemicals close to the source), then they break the chain, as even if there is a pathway, there is no pollutant to get into the aquifer. If there is a pollutant, the chain can still be broken, by not allowing a pathway to open up. This could be achieved by ensuring that no trenches are left open on the site and are appropriately backfilled. The same applies to any investigative boreholes on the site during any development, these can act as a conduit to the source aquifer, so must be promptly backfilled or secured.

11.2 Identifying Risks

Potential risk factors were discussed in an internal paper by Portsmouth Water (2014). These are addressed as hazards discussed below, along with potential mitigation measures. A spreadsheet with the development risks is provided in Appendix D shows risk scoring for different activities/hazards depending on the projected severity and likelihood of occurrence. The Portsmouth Water (2014) paper listed risks, issues, perceived hazards etc., a summary of which are below.

- Risk to Water Quality;
- Doubling the risk to the springs – moving offices and redeveloping old office area;
- Puddle clay barrier reliance;
- Mobilisation of ground contamination;
- Climate change;
- Sea level rise;
- Meeting future demand from Havant source;
- Future water quality changes,
- Risk from foul drainage;
- Introduction of new drinking water standards;
- Unpredictable events;
- Continuity of the springs;
- Use of open space around the ponds;
- Water Safety Plan Approach

The list above, as drawn from the document, does not form a conventional basis on which to complete a risk assessment. BAHS have extracted the individual activities that pose a hazard as part of the risk assessment. Each activity is then considered in terms of the risk(s) posed, an initial risk score, mitigation measures that could be applied and then the residual risk posed assuming the mitigation measures were adopted and effective.

11.3 Summary of Risk

The risk posed to the Havant Springs water supply can be simplified to a risk to the quality of water and the quantity of water that remains available for abstraction purposes. The springs are potentially vulnerable to pollution, especially any contaminants that are introduced deep into the source Chalk aquifer, where they could migrate. In the shallower aquifer, largely the drift material, the risk is lower, as the clay bund helps to some extent to exclude this shallower water, and the artesian nature

of the springs maintains a continuous positive hydraulic gradient upwards. This ensures that water is continuously flushed out of the springs, rather than infiltrating downwards, and can help prevent spread of contamination. However, in flushing water out of the ground, any contamination already in the springs then has to be treated before it can be put into supply.

The risk that current or future activities on or off site may affect the amount of water available for abstraction is real, although not likely to be influenced by current or proposed activities on site. This study has established that the springs occur at this locality due to specific geological structures which only occur directly beneath each spring. The springs will thus not move more than a few metres in any direction due to adverse impacts resulting from any current or planned activities.

The artesian pressures driving the springs results from rainfall recharge entering the ground far to the north over a very wide area. Thus the magnitude of flow from the springs would not be influenced by on site activities. The total volume of water rising from the springs may vary due to changes in rainfall recharge which is clearly not influenced by on site activities, current or planned. The artesian head could be reduced if new pathways for groundwater to rise to ground level were created, for example if the confining layer(s) over the Chalk were compromised by piling. If this occurred the Environment Agency (EA) would force the perpetrator to restore the barrier, equally the EA would not permit or consent activity with the same outcome as this would constitute a new groundwater abstraction which the EA will not allow in this area.

There will always be some risk to groundwater and water quality, from both on-site and off-site activities, some of which can be managed whilst most cannot. Where risks are identified, they should be evaluated, and appropriate ways provided to mitigate the risk if possible. Residual risks then should be calculated, so the Company can then decide the risk appetite that it has for that activity and make a final decision whether or not to permit it or not.

11.4 Assessed Risks & Mitigation Measures

The following section sets out the individual activities identified as posing a potential hazard starting with those posing the highest risk. For each the risks are listed and a risk score generated. Mitigation measures are then set out and the risk score reassessed to provide a residual risk scoring which assumes the mitigation measures are implemented and effective. The spreadsheet based risk assessment for all of the following activities/threats are provided in Appendix D.

Site Investigations

Assessed Risk:

- Site investigations often involve drilling pilot holes, boreholes, trial pits and other excavations on a site prior to works to prove ground conditions.
- These create multiple pathways to the receptor beneath, especially where protective confining layers are breached.
- Risk to the receptor is assessed as high.

Mitigation Measures:

- Supervision of works must be ensured
- All method statements for drilling, depths, materials to be used etc. must be submitted in advance of works
- Strict chlorination of equipment is required on site at all times
- All boreholes or other excavations must be promptly backfilled
- Boreholes should be terminated at least 3 metres before the Chalk is reached
- No wastes must be stored on site, but taken off-site and dealt with appropriately
- No discharge of wastes or other on site are permitted during the works – can provide a pollutant link via the pathways created to the receptor
- Residual Risk assessed as low to medium

Piling During Building Construction

Assessed Risk:

- Piling creates pathways from the ground surface into the aquifers (receptor) below, and can cause turbidity issues, as well as potential contaminant pathways. Piles can also affect groundwater movement, and block / disrupt groundwater flow.
- Could mobilise historical contaminants already in the subsurface
- Risk to the receptor is high.

Mitigation Measures:

- Piles are to extend no deeper than 3m above the top of the Chalk surface at any point if such a system is required on site
- Supervision of works during piling must be ensured to ensure best practice on site
- All method statements for piling, depths, materials etc. must be submitted in advance of works for approval
- No discharges to be made to ground during the works
- All spoil and wastes to be taken off-site and dealt with appropriately (see “Discharges during site construction” below)
- Piling should be terminated at least 3 metres before the Chalk is reached
- Residual Risk assessed as low to medium

Mobilisation of Historical Contamination

Assessed Risk:

- Documented and un-documented historical contamination of the ground could be mobilised by building work on site. The risk would be that contamination may enter groundwater.
- Risk to receptor is low- medium if no pathway is available
- Risk to receptor is high if pathways are available.

Mitigation Measures:

- By completing a land use survey, assessed all historical uses of chemicals and locations across the site a targeted site investigation should locate any potential contamination allowing them to be targeted, treated and/or removed
- Residual risk is assessed as low

Discharges During Site Construction

Assessed Risk:

- These are pollutants (may be chemical or biological), and can reach the receptor via pathways on site
- Risk to receptor is low- medium if no pathway is available
- Risk to receptor is high if pathways are available

Mitigation Measures:

- Areas to store materials safely on sites must be clearly laid out and this information widely circulated to all working on the sites
- Drip trays or other appropriate measures should be available during the works to avoid chemicals leaking to ground
- Disposal measures for wastes must be in place beforehand, and submitted via method statements and risk assessments before the work is carried out
- No disposal of wastes or other materials is made on site
- RA-MS must identify any pathways and receptors on site before / during works and ensure that these are appropriately protected to reduce risk of introduction of pollutants to potential pathways
- Residual Risk assessed as low

Roadways

Assessed Risk:

- Provide potential pollutants in run-off such as Poly Aromatic Hydrocarbons (PAHS) from brake dust, road salt, hydrocarbons, pesticides / herbicides, bacterial contamination and other materials
- Risk is low to receptor if pathways are not available to the receptor adjacent to roadways as often low concentration, but severity is potentially high
- Risk is med-high if run-off is introduced to the aquifer by soaking away into ground, along a pathway

Mitigation Measures:

- Ensure sufficient drainage is built in to any plans
- Minimise areas where direct run-off from roadways could infiltrate into the aquifer source
- Ensure open trenches or other pathways to the aquifer are not in the vicinity of any roadway
- Residual Risk assessed as low

Car Parks

Assessed Risk:

- Provide potential pollutants in run-off such as PAHS from brake dust, road salt, hydrocarbons, pesticides / herbicides, bacterial contamination and other materials
- Risk is low to receptor if pathways are not available to the receptor adjacent to car parks as often low concentration, but severity is potentially high
- Risk is med-high if car park run-off is introduced to the aquifer by soaking away into ground, along a pathway

Mitigation Measures:

- Ensure sufficient drainage is built in to any plans around the edges of car parks
- Ensure that oil interceptors / filters are incorporated into the design to capture any run-off to break the pollutant chain
- Minimise areas where direct run-off from car parks could infiltrate into the aquifer source
- Have appropriate kerb height to accommodate high rainfall events
- Ensure that cars are parked only on designated sites where the risk can be minimised
- No parking directly over aquifer – only on hard-standing or other material that does not allow infiltration directly into ground, and can be captured and filtered first
- Ensure drainage is removed offsite as quickly as possible, and ensure that the drainage capacity is able to accommodate water volumes that may be experienced in a 1 in 100 year flood event
- Residual Risk assessed as low

SUDS (Sustainable Urban Drainage Systems)

Assessed Risk:

- These are often required by Planning Departments on new developments as a way of allowing infiltration of water to ground that normally would fall on impermeable surfaces such as roads or pavements, and be lost to drainage systems.

- These can include borehole soakaways for roof water drainage, swales, or depressions that allow water to infiltrate quickly into the ground
- Provide a pathway along which pollutants can reach the receptor below
- Risk to the source is high as cannot regulate what pollutants end up in surface water naturally and artificially that then infiltrates into the ground

Mitigation Measures:

- No soakaways, swales or other SUDS permitted anywhere on the Portsmouth Water site, on operational site or other
- Ensure that surface water is diverted away from the site and disposed of to the surface water drainage network
- Residual Risk assessed as low

Foul Drainage Network

Assessed Risk:

- Can act as a pathway to a receptor
- Trenches produced to bury pipes in can provide paths from ground surface to aquifer
- Risk to receptor are high via contamination of the source

Mitigation Measures:

- Clear areas to store materials safely on sites must be available and this information widely circulated to all working on the sites
- Disposal measures must be in place beforehand, and submitted via method statements and risk assessments before the work is carried out
- No disposal of wastes or other materials is made on site
- RA-MS must identify any pathways and receptors on site before / during works and ensure that these are appropriately protected to reduce risk of introduction of pollutants to potential pathways
- Trenches must be promptly and appropriately backfilled with low permeability materials to avoid pathways being created
- Whilst open, trenches must be covered whenever not being worked in
- Chlorination of plant and equipment during works must be adhered to
- All infill must be inert and clean before being placed in the trenches
- Residual Risk assessed as low

Mains Water Network

Assessed Risk:

- Can act as a pathway to a receptor
- Trenches produced to bury pipes in can provide paths from ground surface to aquifer
- Risk to receptor are high via contamination of the source

Mitigation Measures:

- Clear areas to store materials safely on sites must be available and this information widely circulated to all working on the sites
- Disposal measures must be in place beforehand, and submitted via method statements and risk assessments before the work is carried out
- NO disposal of wastes or other materials is made on site
- RA-MS must identify any pathways and receptors on site before / during works and ensure that these are appropriately protected to reduce risk of introduction of pollutants to potential pathways
- Trenches must be promptly and appropriately backfilled with low permeability materials to avoid pathways being created
- Whilst open, trenches must be covered whenever not being worked in
- Chlorination of plant and equipment during works must be adhered to
- All infill must be inert and clean before being placed in the trenches
- Residual Risk assessed as low

Non WRAS approved / non-compliant Regulation 31(4)(b) materials in contact with potable water

Assessed Risk:

- Using non WRAS approved or non-compliant Regulation 31(4)(b) materials that are directly in contact with raw water abstracted for potable supply may be in breach of Drinking Water Inspectorate Regulation 31(4)(b). This would be coatings of the spring collection chambers and channel
- Risk is low if no pathway available
- Risk of these pollutants is medium – high on their own as their severity may be high if ingested or permit bacterial growth
- Are only a small number of permitted products which can come into contact with potable water
- Non-compliant and non-WRAS products could come into contact with aquifer source outside the immediate site - uncontrollable

Mitigation Measures:

- Treatment of raw water from the aquifer before being pumped into supply
- Ensure all contractors are aware of Regulation 31(4)(b) and have sight of the up to date approved products list
- Ensure that any works within the Clay bund have materials that are Regulation 31(4)(b) compliant only as are coming into contact with potential raw potable water supply
- Minimise use of non-compliant products if at all possible on site
- Avoid direct contact with raw and treated water wherever possible
- Residual Risk assessed as low

Other services

Assessed Risk:

- Can act as a pathway to a receptor
- Trenches produced to bury pipes in can provide paths from ground surface to aquifer
- Oil filled cables buried may leak into the subsurface
- Risk to receptor are high via contamination of the source

Mitigation Measures:

- Clear areas to store materials safely on sites must be available and this information widely circulated to all working on the sites
- Disposal measures must be in place beforehand, and submitted via method statements and risk assessments before the work is carried out
- NO disposal of wastes or other materials is made on site
- RA-MS must identify any pathways and receptors on site before / during works and ensure that these are appropriately protected to reduce risk of introduction of pollutants to potential pathways
- Trenches must be promptly and appropriately backfilled with low permeability materials to avoid pathways being created
- Whilst open, trenches must be covered whenever not being worked in
- Chlorination of plant and equipment during works must be adhered to
- All infill must be inert and clean before being placed in the trenches
- Ensure that any materials used are compliant with Water Supply Regulations, and are appropriately banded or sealed, and an emergency / contingency plan is available for clean-up and mitigation should they be breached or leak
- Residual Risk assessed as low

Fly-Tipping

Assessed Risk:

- Is a potential pollutant - unknown wastes to ground, these could be chemical or biological
- Not easily controlled or policed
- Low risk as likelihood is low

Mitigation Measures:

- Ensure security at site is sufficient and fly-tipping is deterred as much as possible
- Ensure that the chain is broken by not providing a pathway on site to allow contaminants to enter the aquifer
- Residual Risk assessed as low

Use of fertilisers, pesticides, herbicides in gardens and on-site (e.g. Metaldehyde)

Assessed Risk:

- Is a pollutant risk
- Cannot be easily controlled, use cannot be banned
- Low risk without pathway as volumes of contaminants are likely to be low and concentrations also low
- High risk if pathways to aquifer are available

Mitigation Measures:

- Avoid pathways being created to the aquifer below
- Encourage homeowners to safely store chemicals
- On-site storage – ensure drip trays / bunds available if appropriate, and have an appropriate contingency clean-up plan available on site if any leaks are found
- Ensure that chemicals on operational sites are clearly marked, and stored as far away from raw and treated water sources as possible, with barriers in place to stop infiltration to ground
- Do not store chemical close to open trenches, piles or boreholes on the site
- Residual Risk assessed as low

Storage of chemicals – could leak to ground e.g. fuels, oils, cleaning fluids etc.

Assessed Risk:

- Is a pollutant risk
- Cannot be easily controlled, use cannot be banned, are required on operational sites for water treatment and other uses
- Low risk without pathway as volumes of contaminants are likely to be low
- High risk if pathways to aquifer are available

Mitigation Measures:

- Avoid pathways being created to the aquifer below
- Encourage homeowners to safely store chemicals
- On-site storage – ensure drip trays / bunds available if appropriate, and have an appropriate contingency clean-up plan available on site if any leaks are found
- Ensure that chemicals on operational sites are clearly marked, and stored as far away from raw and treated water sources as possible, with barriers in place to stop infiltration to ground
- Do not store chemical close to open trenches, piles or boreholes on the site
- Residual Risk assessed as low

Electrical transformers

Assessed Risk:

- Are a pollutant risk – oil in switches and tanks
- Low risk as oil volumes usually small

Mitigation Measures:

- Must be appropriately banded within SPZ1 and protected security wise.
- Must have appropriate clean-up plans available on-site if found to leak
- Should be sited away from water sources if possible, and if possible, located down-gradient of the source if must be close-by
- Residual Risk assessed as low

Removal of on-site diesel tank

Assessed Risk:

- Is a pollutant risk – hydrocarbons
- Med-High risk as is already buried in the drift material covering the aquifer

Mitigation Measures:

- RA-MS must be submitted beforehand to indicate how the tank will be excavated and removed
- Wastes and spoil must be removed off site
- Tank must be fully drained first before being removed
- Any plant / equipment used during the removal must be chlorinated
- No discharges to ground to be made during the excavation and removal
- Any trenches or excavations must be covered during works to avoid infiltration into ground of surface water run-off
- Infill material must be clean and of low permeability to prevent pathways being created and maintained through the backfill material
- Residual Risk assessed as low

Pets roaming / being walked on the land – animal wastes

Assessed Risk:

- Pollution risk – bacteriological
- Risk is low as likelihood is low and volume of material low
- Risk if pathways available would be medium
- Hard to control

Mitigation Measures:

- Prevent access to walking animals on the springs land – ensure appropriate security available
- Encourage appropriate waste disposal – bins for disposal on any land developed
- Avoid pathways being available for material to get into subsurface – no swales, open trenches etc.
- Residual Risk assessed as low

Car washing**Assessed Risk**

- Pollution risk – chemical
- Risk is low as likelihood is low and volume of material low
- Risk if pathways available would be medium
- Hard to control

Mitigation Measures:

- Ensure that tarmacadam areas have appropriate run-off capture controls in place
- Ensure that run-off containing these chemicals cannot infiltrate into the ground
- Ensure that pathways such as swales, open trenches etc. are not available for these pollutants to get into the aquifer
- Residual Risk assessed as low

If these activities are not controlled, the resulting effects of these chemical and biological pollutants and pathway issues, would pose higher risks to the Havant Springs source, higher treatment costs, possible water quality failures, more frequent outages due to spillages or perceived threats, risk to the supply network, potential interruption to supply, and interruption to WTW processes too.

11.5 Clay Bund & Risk

On-site, the clay bund around the springs protects from shallow groundwater infiltration, preventing these pollutants from reaching the source. If this is breached in any way, a potential pathway into the receptor is created. It is unknown how many times, and exactly where, the bund has been breached in the past in order for services on site to be installed. However, for the future, all breaches must be recorded, with the location and depth, reason for the breach, how it is to be repaired, and the steps taken to minimise contamination of the source.

All Risk Assessment – Method Statements (RA-MS) must be submitted to Portsmouth Water in advance of any works that may breach the bund, detailing the method of works, what materials are to be used (should be WRAS approved and compliant with DWI (Drinking Water Inspectorate) Regulation 31(4)(b) as will be in contact with a raw potable water source). Works outside of the bund may use non-compliant materials, and come into contact with the Chalk groundwater then abstracted at the springs. This is uncontrollable, but any materials used inside the bund for coatings on the collection chambers and channel walls should be Regulation 31(4)(b) compliant only as come directly into contact with raw potable water.

Any trenching poses a pathway risk, with potential exposure of the source receptor to surface pollutants. Trenching undertaken during breaching of the bund must be carefully planned and carried out, ensuring that no discharges are made, to avoid

pollutants getting into the ground. Trenches must be backfilled promptly and appropriately, with low permeability, clean materials that have been approved by Portsmouth Water. The clay bund, wherever removed to allow excavation or service laying, must be replaced with low permeability material, again such as clay, to at least the same original specifications, or that specified by Portsmouth Water, as deemed necessary to avoid pollutant contamination.

It should be assumed that the top section of the bund has over time been compromised due to excavations and natural decay of the unsaturated sections of the bund above the permanent water table. This Assessment recommends that the bund is grubbed down to a consistent depth along its entire length and renewed with a reliable seal/key into the original bund below. Pump testing of shallow boreholes completed into the drift on either side of the bund should be completed at intervals along its length to test the structures integrity.

With the clay bund in place, it is unlikely that a sewer collapse in the new housing development in Zones A or C would present too high a risk to the springs. The continuous positive upward hydraulic gradient would also reduce the risk of any of the spilled sewage from spreading into the aquifer. However, there is still a low risk of this happening, and the aquifer outside of the bund being affected. Mitigation of this might include regular inspections of the sewage pipes to proactively check for collapses, or double skinning around the pipes. No laying of any foul sewerage network is to be permitted within the clay bund. Misconnections from homes can also pose a risk, where connections from houses and washing machines leak into the surrounding ground, or often connect into watercourses. Ensuring that any connection into the local foul sewerage network is carefully constructed is key, and to check for any breaks. These misconnections can lead to high phosphate concentrations in groundwater.

The installation of a shallow bund (similar to that already installed around Havant Springs) around any new housing development could in itself assist in reducing the risk of unwanted discharges spreading into the subsurface, and potentially affecting the springs. It would not prevent substances from getting into the aquifer, but it could assist in containing any discharges made to ground either during, or after, construction of the housing development.

11.6 Climatic Change

Climatic changes pose the greatest risk to the continuity of the Havant Springs as it has the potential to change the pattern of groundwater recharge. This in turn could change the seasonality of the spring flow and could at worst reduce the amount of water available for abstraction. Climate change is forecast to result in both wetter

summers and winters which should lead to greater recharge to the Chalk, the risk is not controllable and assessed as being low.

Climate change may result in higher sea levels, however this would not be affected by activities on site and would need to be addressed irrespective of any re-development of the site.

11.7 Importance of the Havant Springs

The importance of the Havant Springs source of water to Portsmouth Water cannot be underestimated, the springs are a key strategic source which warrant the maximum protection that can be offered. This study plays an important part in safeguarding the springs by identifying the mechanisms controlling the presence and emergence of the springs. The advanced hydrogeological conceptual understanding of the source which shall be used to assist with compliance with future changes in drinking water standards and protection of the water source.

The improved understanding of the springs, the site and hydrogeological context means PWL can assess the risk posed to the source from unplanned events and incidents. PWL can also assess which activities may be permitted in the vicinity of the springs as the vulnerability of the sources can be assessed more effectively now the site is better understood.

The risks listed in the DWSP are for the catchment and site. The Company needs to decide its' risk appetite, and make final decisions on activities undertaken at site. This report is only for guidance on the risks to the springs from re-development activities, so there is no comment on this risk aspect.

11.8 Zone Classification

From the geophysical study, the site conceptual model has established that a zone of faulting is located in the centre of the site, and is the key mechanism responsible for the upwelling of the springs in this area. It has also identified slight mounding of the top of the Chalk in the SW area of the site, in Boiling Meadows, where another spring exists. These two areas are key water production areas, and as such this Assessment has zoned the site in terms of areas where activities would pose a low, medium or high risk to the springs, see Figure 25.

The PWL head office site has been divided into five zones, A through to E, Zones B and D have been coloured red, for high risk, Zone A has been coloured orange, for medium risk, and Zone C has been coloured green, for low risk to the springs assuming the proposed developed progresses. No development in Zones B and D is

recommended, potential development with strict supervision and conditions in place could be undertaken in Zone A. Zone C could be developed as the new office site, but again with careful supervision to avoid contamination of the source.

Zone A is the northernmost section of the site, encompassing the existing offices, laboratory and two main car parks. The southern boundary of the Zone runs 3m north of the clay bund extending around the springs. This 3 metre stand-off zone from the bund is to ensure no development close to the bund can be undertaken and potentially overstep into this protected area. The stand-off should also be used to maintain access to any part of the bund so that any necessary maintenance can be undertaken without impediment.

This Assessment has adopted a similar 3 metre standoff vertically between the base of any boring, pile, foundation or below ground structure and the top of the Chalk. The Environment Agency operates a similar reasoning for piling, where a stand-off of at least 3m above the base of the London Clay is used in London to protect the deep confined Chalk aquifer. This prevents a pathway being created that may reach the top of the Chalk.

Zone B encompasses the springs themselves along with the collecting channels, running through the centre of the site. Its' boundary is 3m outside of the bund to the north, and 3m outside of the stream to the south. This covers the faulted zone through which the springs arise, and encompasses the entire clay bund. This zone also includes part of the yard to the western side, owned by Portsmouth Water. Although this has already been developed to some extent, further change of this area should be avoided as the fault zone and possibility for springs continues beneath this area and off site in the same direction.

Zone C covers the southern area, encompassing much of the meadows which have been put forward for redevelopment as the new Company headquarters, but excludes Boiling Meadow Spring in the far south west corner of the site. The zone here extends to a line 3 metres south of the stream boundary to the north, right up to the road boundary to the south, and abuts up to Zone D to the west. This could be developed as the new offices site, as it is down-gradient of the springs, and poses less risk than Zone A to the north does to the Chalk aquifer. The Chalk in this area is also generally deeper and predicted to be more confined and thus protected than at any other point across the site.

Development in the immediate vicinity of the stream is discouraged, as surface pollutants from development could migrate or be washed into the surface watercourse, and could seep into the ground, and the Chalk aquifer. The risk of this infiltration of polluted water is low, given that the positive hydraulic gradient of the springs should help to flush out any water coming in from above. However, there is still a risk posed to the site by developing so close to a watercourse. This can be mitigated against, and the risk reduced, by ensuring that any development close to the stream is carefully planned, and the appropriate land-use selected. For instance, if car parking was

envisaged for this area close to the stream, it should be made of a non-permeable material, be appropriately bunded and have sufficient drainage to avoid overtopping of surface water into the stream, and incorporate oil filters to capture and store any oil or other hydrocarbons washed off the surface. Drainage from this sort of development must be put to foul sewerage, and not allowed to drain into the adjacent watercourse.

A small standoff zone, or riparian zone, from the waterbody edge should be retained, hence the 3 metre stand-off proposed. This helps as a natural buffer zone against high nitrate and phosphate run-off and other pollutants (the plant growth absorbs some of the nutrients rather than washing directly into the watercourse), and will assist in protecting the stream from any surface pollution encountered. This 3 metre stand-off could be reduced, depending on the Company risk appetite. The larger the stand-off, the lower the risk, however, this may conflict with development proposals. As long as appropriate mitigation measures are put in place such as a double height kerb, an impermeable tanked surface, oil interceptors, and a connection to the local sewer network that has adequate drainage capacity to accommodate volumes experienced in 1 in 100 years surface water flooding, then the risk to the stream from pollution can be considered to be low.

Zone D covers the Boiling Meadows Spring in the south-western corner of the site, it is deemed to be vulnerable if redevelopment was to take place in this immediate vicinity. Zone D provides a stand-off around the spring and the Company boundary, based on the principle of the Environment Agency's 50m Source Protection Zone (SPZ) radius which is the minimum radius of protection provided for any assessed potable water source. The Chalk is also close to surface in this area (Figure 23 shows that the top of the Chalk is within a few metres of ground level to the east of the Spring, the zone therefore reflects the Environment Agency's principle of protection and the geological structure and associated risk in this area. It is key that this area is not developed, in case any pollution risk is introduced to the aquifer in this area.

The Spring is not protected by any clay bund, and is thus more sensitive to pollution than the main springs in the centre of the site. Nevertheless, low risk development could be permitted, such as car parking, as long as adequate mitigation is put in place. This would include double height kerbing all the way around the car parking area, an impermeable surface, oil interceptors, and a connection to the local drain network [taking the water off site] that has adequate capacity to accommodate predicted runoff volumes that may be experienced in 1 in 100 year rainfall events.

Car parking should not be developed over the top of the spring, a stand-off zone around the actual collection chamber is strongly recommended, to allow access for maintenance, and to avoid direct infiltration into the spring itself. The current hedge line represents a natural boundary which could be retained thereby limiting significant development closer to the spring.

Zone E is an extension of Zone B, just to the West of the latter zone. Zone E covers the area around the historical fuelling point and tank, and yard, already used as a car

parking, storage and tarmac area. This area is adjacent to the springs, on the E-W springline that extends for around 1.5 kilometres in total, incorporating the springs at both Havant and Bedhampton, amongst others. As the same faulting mechanism is inferred to also underlie this area, this zone could be highly sensitive to pollution. However, the Havant Springs on-site are protected to some extent from any shallow pollution by the Clay bund, assuming the continuing integrity of this bund structure, so immediate risk to the springs on-site by surface activities is fairly low. Limited development of this zone could be considered providing there was no possibility of drainage, surface water or foul water entering the ground. All identified risks would have to be demonstrated to be mitigated to an acceptable level with very specific risk assessments for each. Removal of the diesel tank must be carefully undertaken with any new hydro-geological observations documented to help expand the understanding of this area.

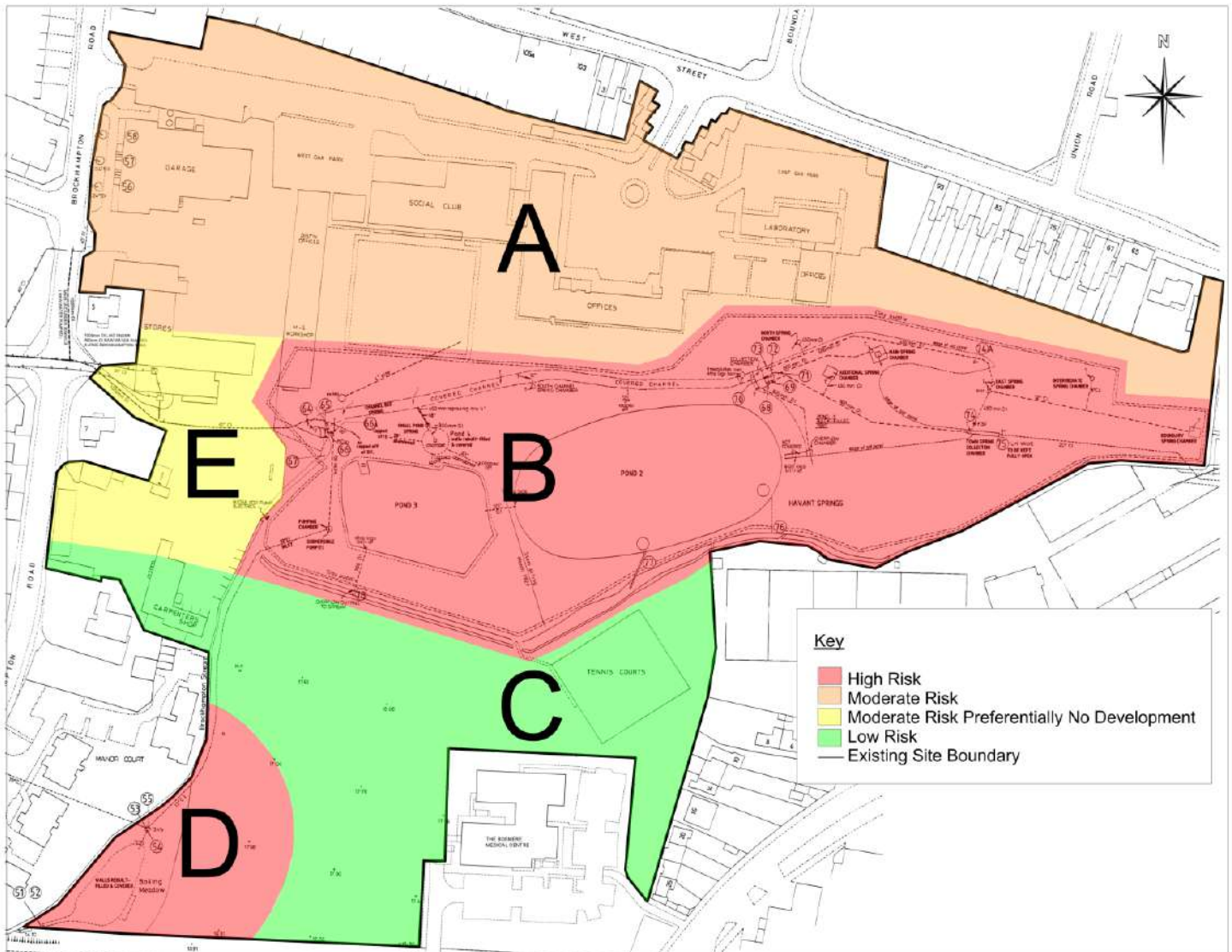


Figure 25: Havant Springs Risk Zones A to E

12 Recommendations

Using the data gathered on-site during the geophysical site investigation works and data during the literature review, it has been found that due to the nature of the springs, development of part of the Havant site could be permitted, as long as certain activities are prevented and others are restricted and carefully controlled. The main risk to the springs will be during any site development, so this critical period needs to be carefully planned, designed, managed and supervised to minimise the risk posed to the springs. Specific recommendations and mitigation measures to deal with the main risks associated with site development proposal have been discussed in detail in Section 11.

Re-development of Zone A would pose a medium risk to the springs during construction, whereas any development of zones B or D would pose a high or very high risk to the springs. Development of Zone C is put as low risk. It is recommended that any further development within Zone B is not permitted (apart from those activities / developments required to further maintain or protect the water source), as this is the key areas where the springs emerge at surface, and is critical to maintain the quality of spring water. Zone D is high risk, and no housing or other building development should be considered for this area. However, limited development such as car parking, could be considered, only if appropriate mitigation measures were put in place to keep risk low. Development of Zones A, C and E would require careful supervision and management, the risk posed to the springs from contamination could be reduced to an acceptable level through mitigation measures.

Re-development of Zone A would involve the demolition of the existing office and other buildings, and erecting of new housing. Once the dwellings were established the risk posed by ongoing activities should be low or possible low to medium risk providing the infrastructure and controls are built into the design appropriately. Re-development of Zone C would involve creating a new head office for Portsmouth Water, again the greatest risk would be posed during construction with relatively low risk activities continuing once completed.

Zone B would be left undeveloped, in order to prevent direct contamination of these spring sources. Figure 26 illustrates the risk zones with the planned development areas, this plan suggests that the head office development could be achieved without encroaching on Zone B and with minimal effect on Zone D. As the site would be in the ownership and management of PWL mitigation measures could be put in place and maintained to reduce the risk to Zone D from perhaps car parking or landscaping in the boundary area.

Part of the residential development would potentially cross Zone E in the west of the site. As this part of the site has already been partially developed and used for various purposes by PWL, it is the opinion of this Assessment that some re-development of the area could be considered, where the end risks were very low and development was

exceptionally carefully controlled. This might include the current uses of car parking (if run-off was sufficiently captured and directed away from the aquifer into the foul sewerage), storage of materials (if appropriately stored and bunded) or other development not requiring intrusive investigations and digging into the subsurface at this point. Zone E potentially lies on the springline running E-W across Havant, and is an extension of Zone B in the absence of more information on the sub-surface. Careful removal of the diesel tank is a must within this zone, and should be carefully planned and executed to avoid disruption of groundwater, or allowing discharge of any fuel or other materials into the aquifer, to minimise risk to this source.

Minimising indirect contamination should be achieved through careful management and supervision of any development works, and putting in place conditions on development where required to assist in minimising risk. It is strongly recommended that if any intrusive site investigations are to take place on the PWL site prior to development, that they be carefully planned and monitored throughout, to minimise risk to the springs.

Groundwater Protection: Principles and Practice - Part 4 – Position Statements and Legislation Consultation (GP3). (Environment Agency, 2013), should be consulted. This document outlines and then details various activities that may cause pollution to groundwater, and introduces ways of preventing this, by excluding activities from vulnerable or high risk areas, such as SPZs. Many of the position statements in this document have been produced with planning in mind, to guide how new developments impact on groundwater. Position statement P4-3 discusses sewage effluent discharges inside SPZ1, alongside P4-5 through P4-8 which include; Discharge of clean roof water to ground; connection to public foul sewer; Use of deep soakaways for surface water and effluent disposal, and; Developments posing an unacceptable risk of pollution, amongst others. This should assist in guiding any conditions to be imposed on any new development eventually permitted on the Headquarters site.

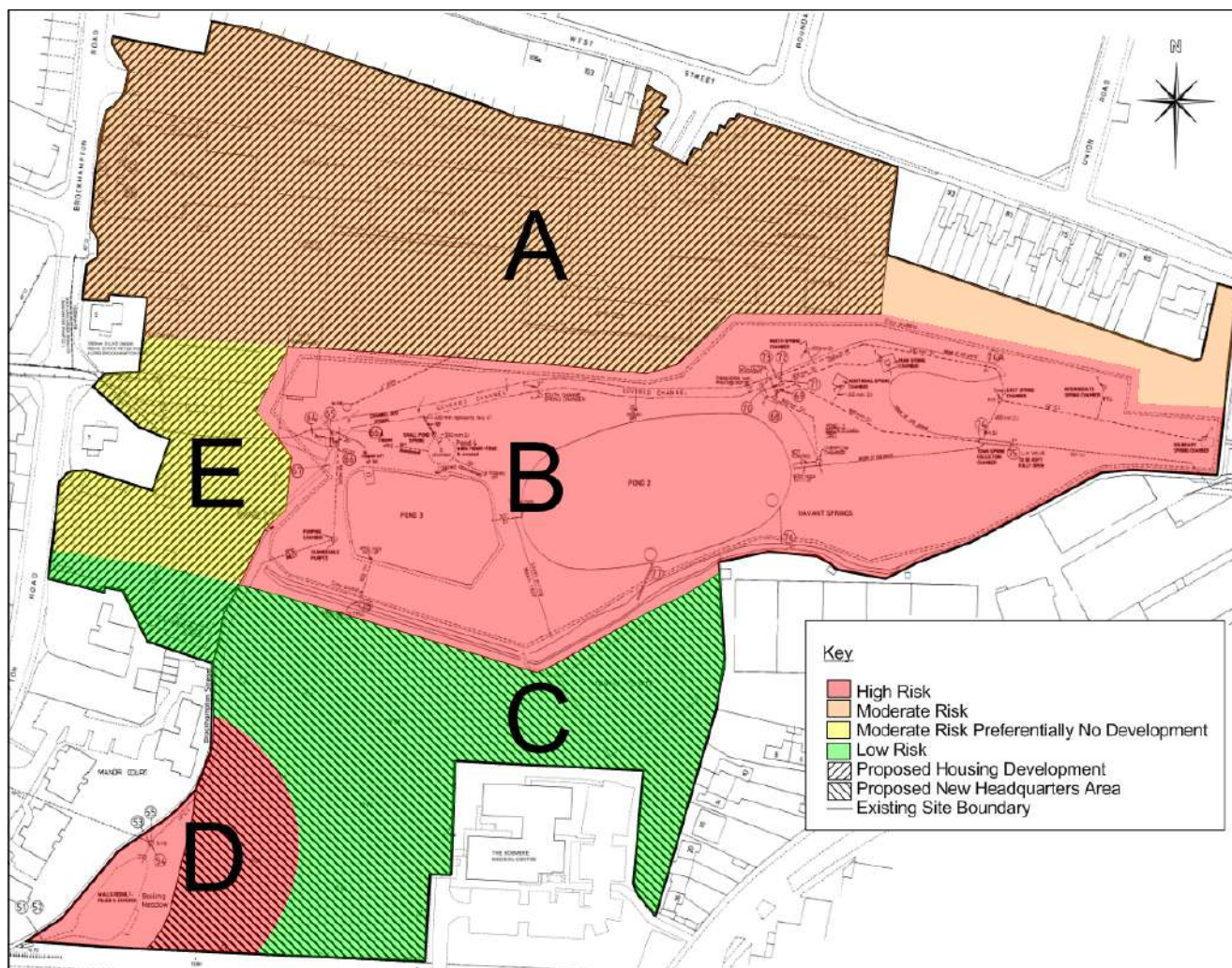


Figure 26: Risk Zones & Planned Development areas

For the PWL headquarters site, the following recommendations are made concerning the potential re-development of the site:

- No development to be permitted in Zones B [within the bunded area] and D apart from that required by Portsmouth Water to continue maintaining and protecting the water sources within, and possibly car parking if risk appropriately mitigated against, in Zone D only.
- Limited development of land in Zone E outside the bund along the western edge of the site.
- Any works within any of the zones must have RA-MS produced prior to the works starting, and must be approved by PWL.
- Only DWI Regulation 31(4)(b) material should be used if they are to come into contact with potable water

- No piling, boring, foundations, below ground structures, excavations, etc., be permitted within 3m of the top of the Chalk in Zones A or C in any circumstances.
- No piling permitted within Zones B and D
- Any historical breaches of the clay bund should be reinstated
- Hydraulic testing of the bund at intervals along its length is recommended
- No soakaways / swales / SUDS to be permitted in any of Zones A-D
- No public access permitted in Zones B – D (any access point to new buildings in Zone C need to exclude Public from getting unsupervised access to Zones B and D.
- Any new car parks within Zones A, C or E must be fitted with oil interceptors
- No industrial activities be permitted on the new development in Zones A and C
- All works involving utilities, drainage or below ground excavation work must be carefully installed with the express permission of PWL, and should heed to their specifications and installation methods to minimise potential contamination
- No ground source heating or cooling systems of any form should be permitted on any part of this site unless installed and operated by PWL.
- For any activities to be carried out in any of the Zones for development purposes or other, RA-MS must be submitted and approved by the Company
- Trenching, site investigations, or any other activity that could form a contaminant pathway to the Chalk aquifer, must be carefully planned, supervised and undertaken, and backfilled as soon as possible with clean, low permeability backfill material to prevent contamination from getting through to the aquifer.
- Further investigations into the hydrogeological setting of the surrounding area would assist with the management of the margins of the site, especially to the west and south-west of the site.
- Further investigation work is needed to better characterise the shallow sediments from ground level to the top of the Chalk. These sediments could not be accurately identified from the geophysical data and there exists limited documented evidence of their nature. As their presence and character is potentially the key to the natural protection provided to the Chalk this Assessment considered it a high priority to investigate them further.
- The DWSP should be reviewed in light of the findings of this assessment.

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APPENDICES

- Appendix A BAHS Scope of Work**
- Appendix B Geophysical Data Processing Records**
- Appendix C PWL Site Risk Document**
- Appendix D Risk Assessment Spreadsheet**

Desk Study



Phase I Desk Study

At

**Land to the north of Solent Road, Havant,
Hampshire PO9 1DQ**

For

Vail Williams

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REPORT 14252/DS

Phase I Desk Study

**Job Title: Land to the north of Solent Road, Havant,
Hampshire, PO9 1DQ**

Client: Vail Williams

CONTROL DOCUMENT

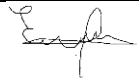
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DOCUMENT TYPE:
PHASE I DESK STUDY

DOCUMENT STATUS: FINAL REVISION: 1.0

DATE: June 2014

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	Eliane S Foteu Madio	

Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.



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Report on a Phase I Desk Study

on

Land to the north of Solent Road, Havant, Hampshire PO9 1DQ

for

Vail Williams

Section 1 Commission

1.1 Commission

Soils Limited was commissioned by Vail Williams to carry out a Phase I Desk Study and a Site Walkover on the site located at Land to the north of Solent Road, Havant, Hampshire, PO9 1DQ.

1.2 Caveat

Whilst reasonable skill and care has been taken to determine the site history and the environmental setting within the time constraints applied by the project, it should be appreciated that uncertainties may occur owing to the natural variability of soil material within a defined area or as a result of unknowns that are associated with contaminated land assessment in general. The site conditions may be different from that indicated by this desk study, particularly on a site with a history of past development. No responsibility can be accepted should such conditions alter the recommendations made in this report.

Section 2 Introduction

2.1 Objective

The Phase I Desk Study was undertaken to advise the client on the risk pertaining to the site, with special reference to former and present day potential contaminative uses. This will also include their impact on sensitive receptors, such as, human health, controlled waters, ecological features, building structures and services.

2.2 Location

The site area was 1.7ha and was located on land to the north of Solent Road, Havant, Hampshire, PO9 1DQ at O.S. National Grid Reference of SU 711 061. The site location map is presented in Figure 1.1 and the full Site Walkover discussed in Section 3.1 of this report.

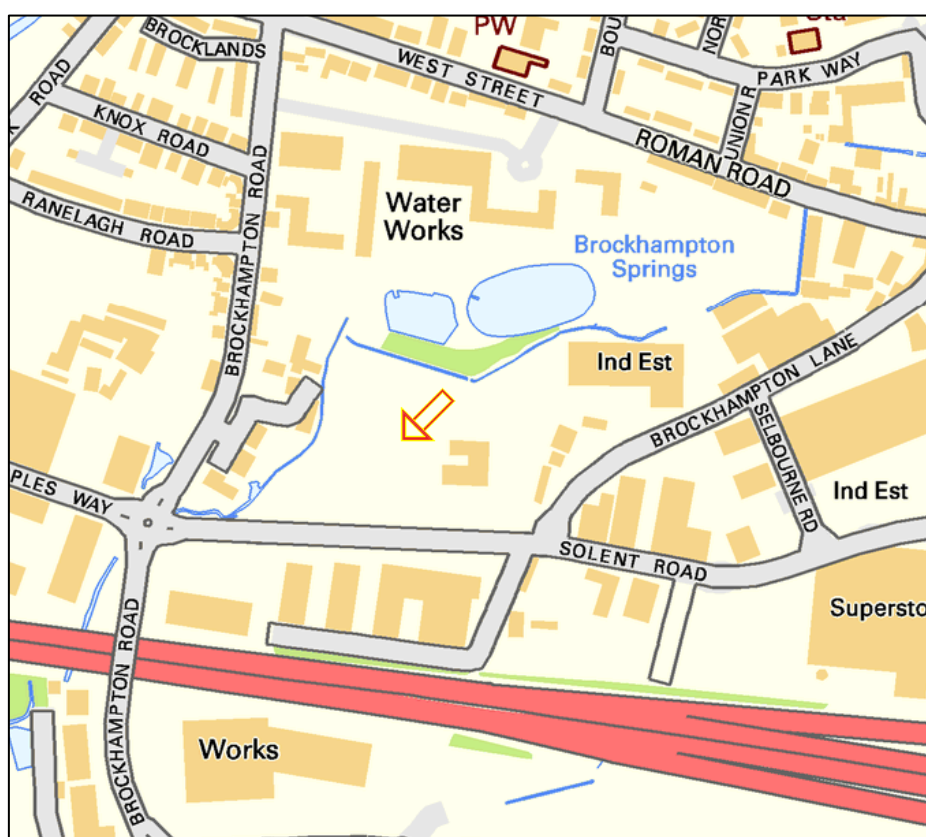


Figure 1.1. Site Location Map

2.3 Proposed Redevelopment

The proposed redevelopment was unknown at the time of reporting, June 2014, but was understood to comprise the construction of residential units.

2.4 Legislation and Liability

The primary legislative mechanism for contaminated land management in the UK is Part 2A of the Environmental Protection Act, 1990 (EPA). Part 2A was introduced into the EPA under Section 57 of the Environment Act 1995 to help deal with the substantial legacy of land contamination. The legislation provides powers in relation to the identification, remediation and apportionment of liability for contaminated land. Part 2A applies where there is unacceptable risk, assessed on the

basis of the current use and the relevant circumstances of the land. It is not directed to assessing risks in relation to a future use of the land that would require a specific grant of planning permission.

Under Part IIA of the Environment Act 1995, Local Authorities are required to identify contaminated land and serve on every person who is an appropriate person a remediation notice setting out what is to be done by way of remediation and the period within which it must be done.

If the person who caused, or knowingly permitted the contaminating substance cannot be found, the owner and/or occupier for the time being of the property can be the appropriate person.

Under the legislation, Contaminated Land is defined as: -

Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused.

Where the Act defines harm as: -

'harm to the health of living organisms or other interference with the ecological systems of which they form a part and, in the case of man, includes harm to his property.'

and pollution of controlled waters is defined as: -

'the entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter.'

In addition, The Radioactive Contaminated Land (Modification of Enactments) (England) Regulations 2006 introduced the additional definition of harm to include: lasting exposure to any person resulting from the after-effects of a radiological emergency, past practice or past work activity.

With regard to contaminated waters, the Environment Act 1995 amends the Water Resources Act 1991 and provides the Environment Agency with the power to force clean-up of historical contamination by issuing a Works Notice, with remediation paid for by the responsible parties.

The Groundwater Regulations (1998) stated that entry of List 1 substances into groundwater must be prevented, and List II substances must be controlled.

2.5 Limitations and Disclaimers

This Phase I Desk Study Report relates to the site located on land to the north of Solent Road, Havant, Hampshire, PO9 1DQ and was prepared for the sole benefit of Vail Williams (The "Client") for the brief described in Section 1.1 of this report.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

There may be other sources of information not included in those listed that hold data relevant to the Phase I Desk Study undertaken at the site that could materially affect the conclusions made in this report.

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 as presented in section 2.4 of this report.

Where a contaminative use is identified in the Phase I Desk Study this does not determine whether contamination has actually occurred, or if it has the degree to which it may have taken place. An intrusive investigation(s) and analysis is required to establish the nature and degree of any contamination present.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Soils Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party

Section 3 Site Conditions

3.1 Site Walkover

A Site Walkover was undertaken in May 2014 and the details are presented in Tables 3.1 & 3.2. The site photographs are appended to this report (Appendix D).

Table 3.1. Site Walkover Record (On-site)

On-Site	Use of site	Open field.
	Structures	Open field. Access restricted but possible tennis court area to north-east of site.
	Site topography	Sloped down to the south.
	Site covering	Open grass.
	Vegetation	Mature trees and shrubbery scattered across the site, with mature trees along the site boundaries.
	Contamination Sources	None noted.

Table 3.2. Site Walkover Record (Off-site)

Off-Site	Use of Land	Portsmouth Water Works to N. East – commercial, a with medical centre to the immediate east of site. Some scattered residential. West – residential South – Industrial and commercial units.
	Area topography	Sloped down to the south.
	Vegetation	Grass, mature shrubbery and trees associated with residential gardens and mature trees along boundary lines.
	Contamination Sources	Water Works to north: Chlorine tank, underground diesel tank, fleet maintenance workshop, chemical storage, electric substation. Industrial units to S

3.2 Site Drainage

Streams and ditches were noted to the north and western boundaries of site. Springs and a GSPZ abstraction well were noted to the north at the Water Works site. Large man-made lakes were noted to the north of site and were fed by the natural springs.

3.3 Site Photographs

The site photographs are appended to this report (Appendix D).

Section 4 Geology, Hydrogeology, Hydrology and Radon

4.1 Anticipated Geology

The 1:50,000 BGS Map showed the site to be located on a number of superficial deposits including Alluvium (to the centre), Head (to the north-west) and River Terrace Deposits (Undifferentiation) (to the south-east).

4.1.1 Alluvium

Alluvium is the most recent river or estuarine deposit and generally comprises silty clays usually with an appreciable organic content. Lenses of sand and gravel are also commonly found, as are pockets of peat.

4.1.2 Head

Head Deposit are drifts produced by solifluxion, the downslope movement of debris outwash during the periglacial period, and characteristically comprise poorly sorted soils of local derivation.

4.1.3 River Terrace Deposits (Undifferentiated)

The rivers of Hampshire have deposited extensive spreads of River Terrace Deposits in the Southampton area, representative of ancient floodplains. In total, eleven terraces have been recorded. The River Terrace Deposits consist predominantly of gravels made up of subangular to subrounded flints with a significant sand component locally with lenses of silt, clay or peat.

The five highest terraces have appreciable clay content. Poorly sorted, clayey and sandy silts and silty clays overlie the 1st, 3rd, 5th and 6th terraces and locally at above terrace gravels.

4.1.4 Lewes Nodular Chalk Formation

The Lewes Nodular Chalk Formation is composed of hard to very hard nodular chalks and hardgrounds with interbedded soft to medium hard chalks (some grainy) and marls; some griotte chalks. The softer chalks become more abundant towards the top. Nodular chalks are typically lumpy and iron-stained. Brash is rough and flaggy or rubbly, and tends to be dirty. First regular seams of nodular flint, some large, commence near the base and continue throughout.

4.2 Hydrogeology

To assess the vulnerability of groundwater to contamination, consideration must be given to the leaching characteristics of the overlying soils and the characteristics of the strata in the unsaturated zone. Information on the geological strata, such as lithological type and permeability characteristics has been combined with the physical properties of the soil to produce varying degrees of vulnerability. Table 4.1 presents the hydrological data that is relevant to the site.

Table 4.1. Hydrogeological Assessment

Hydrogeological Data		Comment	Risk likely?	
			Yes	No
On-site Aquifers	Superficial	Secondary A Aquifer ¹	✓	
	Bedrock	Principal aquifer ²	✓	
Source Protection Zones (SPZ)		Onsite/ GSPZ I with abstraction borehole to north of site	✓	
Abstraction	Potable	145m N – Portsmouth Water Ltd	✓	
	Non-potable	None within 250m		✓
Sensitive land uses		Nitrate vulnerable land onsite	✓	
Surface Water Features		Onsite - Stream	✓	
Flood Risk		Extreme Flooding from Rivers or Sea without Defences	✓	

Notes: ¹ 'Secondary A Aquifer': these are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. ² 'Principal aquifer': these are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

The overall groundwater vulnerability of the site was an aquifer (i.e. minor) with soil class High Urban (H)U (i.e. soils of High Leaching Potential (U)). Groundwater is considered vulnerable to potential contaminants because the most sensitive classification of groundwater vulnerability is Principal aquifer which has high leaching potential as well as a GSPZ I and potable abstraction well.

Any works or development, which may have an impact on surface water, aquifer or groundwater quality, must be approved by the Environment Agency prior to implementation.

According to Environment Agency guidance given to Local Authorities, a flood risk assessment is may be required as a part of the application for planning permission and guidance should be obtained from the Planning Department. As the area of the site exceeds 1.0Ha a site specific flood risk assessment is required for drainage purposes.

4.3 Hydrology

The anticipated groundwater flow direction is given in Table 4.2. The approximate elevation of the site was ~5.0 m AOD (Above Ordnance Datum). Given that there is an abstraction borehole located to the north of the site, the groundwater flow in the aquifer would flow toward the borehole abstraction well. Therefore all off site sources, potentially, within the SPZ to the south could impact the site.

Table 4.2. Groundwater Flow Direction

Direction	Comment
North	Towards the GSPZ abstraction well to the north.

4.4 Radon Gas

The site **was situated** within an area where protection or risk assessment against the ingress of radon was required. **Radon protection measures** will need to be installed within the proposed new development. It is not possible in the course of a survey or inspection to determine whether

radon gas is present as the gas is colourless and odourless. Tests can be undertaken to assess the concentration of radon in existing structures.

Section 5 Site History

5.1 Historic Map Study

The object of this study was to report on the evidence of site history and redevelopment of the site and its environs from available County Series and Ordnance Survey Maps dating from the mid to late 19th Century to the present day as downloaded from Landmark Environmental.

Maps only represent a “snap shot” of the site and its environs at the date of the survey. Changes that had occurred either to the site and/or the environs may well not have been recorded on the maps and could represent a hazard to the site.

Any distances quoted for features remote from the site have been scaled from the maps and are only approximate. Where dates have been noted in brackets, these are the actual dates applicable to the map editions.

The information reported might not represent all pertinent information that could be obtained.

The interpretation of the maps and/or other data commented on in this report is subjective.

In the following sections dealing with individual maps, only features considered to have a potential contaminative impact on the site and usually within a notional 250 m radius are discussed. The north point and approximate extent of the site are indicated on each figure. The historic maps referred to are appended to this report (Appendix A). A précis of the environs identified, if any from the maps are given in Tables 5.1 and 5.2. Figure 5.1 show their location plans.

Table 5.1. Source of Pollution from Historic Maps

Source No.	Environ	Direction	Distance ¹ (m)	Date Range	
				From	To
1	Portsmouth Water Works with engine houses and reservoirs	N	20-80	1867-1868	2014
2	Tannery	NW	10	1867-1868	1909
3	Washing Factory	E	10	1867-1868	1897
4	Workhouse	NE	200	1867-1868	1909
5	Chamois Leather Works	E	10	1897	1963-1989
6	Nurseries	W	150	1897	1973
7	Parchment Works	NE	180	1897	1909
8	Allotment gardens	N	150	1897	1963-1989
9	Brewery	NW	220	1897	1897
10	Tanks – Portsmouth Water Works	NW	150	1953-1987	1953-1987
11	Works: Foundry, Electronics Factory, Engineering works, Depot	S	50	1963-1989	2014
12	Works: Plastics Factory, Engineering works, Warehouse, Sheet Metal warehouse	SE	200	1963-1989	2014
13	Laundry	NW	250	1963-1989	1993
14	Works/Builders Yard	NE	180	1973	2014

¹ Approximate distance to the site boundary

Table 5.2. Historic Development of the Site

Site Development	Date Range	
	From	To
Open land – springs noted to the south-west corner of site	1867-1868	1867-1868
As previously noted – with pond to south-west corner at previous spring location	1897	1987-1989
As previously noted – with a tennis court to the north-east of site.	1987-1989	1993
Pond no longer noted.	1993	2014

Section 6 Environmental Records and Consultation

6.1 Dataset Information

A Landmark Envirocheck Report was obtained for the site by Soils Limited. A copy of the report is appended to this report (Appendix B) and a summary is given in Tables 6.1 and 6.2.

6.2 Site Sensitivity Maps

No other significant potential sources of contamination were shown on the Landmark Envirocheck Site Sensitivity Maps, which have not been listed in Tables 6.1 & 6.2, and copies of which are appended to this report (Appendix C).

Table 6.1. Environmental Significance Of Data Search

Source	Direction / Distance		
	Direction	Distance (m)	Maximum Radius (m)
Contaminated Land Register Entries and Notices	-	-	250
Discharge Consents (current/active consents only)	-	-	250
Integrated Pollution Prevention and Control	NW	168	250
Local Authority Pollution Prevention and Controls	SE	170	250
Local Authority Pollution Prevention and Control Enforcements	-	-	250
Nearest Surface Water Feature	N	0	250
Pollution Incidents to Controlled Waters (Significant Incidents only)	-	-	250
Prosecutions Relating to Authorised Processes	W	198	250
Registered Radioactive Substances (active only) ²	-	-	250
Substantiated Pollution Incident Register	-	-	250
Nearest potable abstraction point	N	145	250
Nearest non-potable abstraction point	-	-	250
Water Industry Act Referrals	-	-	250
Source Protection Zones	GSPZ I	0	2000
Extreme Flooding from Rivers or Sea without Defences	Onsite	0	2000
Flooding from rivers or sea without defences	Onsite	0	2000
Areas benefiting from flood defences	-	-	250
Flood Water Storage Areas	-	-	250
Flood Defences	-	-	250
BGS Recorded Landfill Sites	-	-	250
Historical Landfill Sites	-	-	250
Licensed Waste Management Facilities	-	-	250
Local Authority Recorded Landfill Sites	-	-	250
Registered Landfill Sites	-	-	250
Registered Waste Transfer Sites	-	-	250
Registered Waste Treatment or Disposal Sites	E	189	250
Control of Major Accident Hazards Sites (COMAH)	-	-	250
Notification of Installations Handling Hazardous Substances	-	-	250
Planning Hazardous Substance Consents	-	-	250
Contemporary Trade Directory¹	Direction	Distance (m)	Status
1. Manufacturers – roller shutters	W	98	Active
2. Tyre dealers	SE	123	Inactive

Table 6.1. Environmental Significance Of Data Search

3. Garage services	E	158	Inactive
4. Tool manufacturers	E	158	Active
5. Brewers	E	158	Active
6. Car engine tuning and diagnostics	E	158	Active
7. Precision engineers	W	111	Active
8. Garage services	E	184	Active
9. Paint and varnish stripping	E	158	Inactive
10. Garage services	E	184	Active
11. Sheet metal work	E	184	Inactive
12. Garage services	E	140	Inactive
13. Metal spinners	E	139	Active
14. Spraying – paint and coatings	E	136	Inactive
15. MOT testing centre	SW	214	Active
16. Plastics – injection moulding	S	50	Inactive
17. Glass production	E	42	Active
18. Printers	W	182	Inactive
19. Engineers	E	201	Inactive
20. Precision engineers	W	173	Inactive
21. Commercial vehicle bodybuilders and repairers	S	60	Inactive
22. Sheet metal work	SW	62	Inactive
23. Precision engineers	E	97	Inactive
24. Dry cleaners	E	97	Active
25. Garage services	SE/S	70/74	Inactive
26. Joinery manufacturers	NE	230	Inactive
27. Car body repairs	E	158	Active
28. Plastic products – manufacturers	SW	131	Inactive
29. Garage services	E	97	Active
30. Precision engineers	E	158	Inactive
31. Tool design and manufacturers	E	158	Active
32. Metal products – fabricated	E	187	Active
33. Garage services	E	187	Active
34. Control panel manufacturers	E	187	Inactive
35. Plastics – injection moulding	E	124	Inactive
36. Plastic product – manufacturers	W	153	Active
37. Photocopiers	W	190	Inactive
38. Metal finishing services	SW	181	Inactive
39. Sheet metal work	SW	214	Inactive
40. Garage services	W	215	Active
41. MOT testing centre	NE	239	Active
42. Plastic products – manufacturers	E	237	Inactive
43. Boatbuilders and repairs	SW	243	Inactive

¹ Those likely to impact the underlying soil and/or groundwater, date not supplied. Most of these activities either (i) operate according to environmental guidance (i.e. environmental permitting or IPPC) therefore may not be considered as source of contamination, (ii) are remote from the site or (ii) are not located up gradient of the site therefore have not direct impact on identified receptors.

² Registered Radioactive Substances are noted within 250m of the site, however these licenses are cancelled/revoked/withdrawn and therefore radioactivity monitoring will not be required.

Table 6.2. Geological Hazards

Source	Nearest distance from site/type
Coal Mining Affected Areas	None within 2000m
Mining Instability	None within 2000m
Natural and Mining Cavities	None within 2000m
Potential For Collapsible Ground Stability Hazards	On-site: Very Low-No Hazard
Potential For Compressible Ground Stability Hazards	On-site: Moderate - No Hazard
Potential For Ground Dissolution Stability Hazards	On-site: Moderate - Low
Potential For Landslide Ground Stability Hazards	On-site: Very Low
Potential For Running Sand Ground Stability Hazards	On-site: Low – No Hazard
Potential For Shrinking or Swelling Ground Stability Hazards	On-site : Very Low
Shallow Mining Hazards	Unknown.

6.3 Soil Geochemistry

For metals lead, arsenic, cadmium, chrome and nickel the potential levels were assessed against the appropriate environmental quality standards (SSV, SGV & GAC) for the sites purposed end use. The results are indicated in Table 6.3.

Table 6.3 Soil Geochemistry			
Determinand	Proposed Land use	Potential Hazard	
		Yes	No
Lead	Residential with plant uptake		✓
Arsenic			✓
Cadmium			✓
Chrome			✓
Nickel			✓

These results are only indicative of the area, so specific site testing may be required. Please note that there are only a limited number of land uses for which data on determinands have been published or can be readily determined.

Section 7 Discussion and conclusions

7.1 General

The findings of the Phase I Desk Study are summarised below:

1. The 1:50,000 BGS Map showed the site to be located on bedrock of Lewes Nodular Chalk Formation, with overlying superficial deposits of Alluvium, Head Deposits and River Terrace Deposits (undifferentiated).
2. The historical maps and former research revealed that there may sources of pollution on the proposed site.
3. Examination of the Environment Agency records showed that the site is situated on a GSPZ I.
4. The Environment Agency Hydrogeological Maps showed that the superficial aquifer to be a **Secondary A Aquifer** and the bedrock to be a **Principal Aquifer**, and an Aquifer with variable permeability class High (U).
5. Although the site was gently sloping down to the south, groundwater flow was in alignment with the GSPZ I abstraction borehole to the north of site.
6. The Building Research Establishment report BRE 211 (2007) showed that **radon protection measures were** required.
7. Environment Agency records showed that the site is at risk of flooding. Therefore, a Flood risk assessment may be required by the Environment agency. Soils Limited can carried out a Flood risk assessment if required.
8. At the time of reporting in June 2014, Soils Limited were awaiting a response from Havant Borough Council regarding any additional information held by Havant Borough Council regarding the site, in particular the Water Works to the north of site.
9. Any suspicious ground conditions encountered during groundworks should be reported to a competent person for further inspection.

Summary of potential on-site contamination sources identified during the study of the historic maps, the Dataset Information and Landmark Envirocheck Report and the Site Walkover are outlined in Table 7.1.

Table 7.1. Summary of Potential Contamination Sources

Sources/Environmental Impact		Direction ¹	Distance (m)	Date Range		Data Origin
				From	To	
On Site	Alluvium	-	0	2014		SGCM
Off Site	Portsmouth Water Works with engine houses and reservoirs	N	20-80	1867-1868	2014	HM & SW
	Tannery	NW	10	1867-1868	1909	HM
	Washing Factory	E	10	1867-1868	1897	HM
	Workhouse	NE	200	1867-1868	1909	HM
	Chamois Leather Works	E	10	1897	1963-1989	HM
	Nurseries	W	150	1897	1973	HM
	Parchment Works	NE	180	1897	1909	HM
	Allotment gardens	N	150	1897	1963-1989	HM

Table 7.1. Summary of Potential Contamination Sources

Sources/Environmental Impact	Direction ¹	Distance (m)	Date Range		Data Origin
			From	To	
Brewery	NW	220	1897	1897	HM
Tanks – Portsmouth Water Works	NW	150	1953-1987	1953-1987	HM
Works: Foundry, Electronics Factory, Engineering works, Depot	S	50	1963-1989	2014	HM & SW
Works: Plastics Factory, Engineering works, Warehouse, Sheet Metal warehouse	SE	200	1963-1989	2014	HM & SW
Laundry	NW	250	1963-1989	1993	HM
Works/Builders Yard	NE	180	1973	2014	HM
Manufacturers – roller shutters	W	98	2014		DS
Tyre dealers	SE	123	2014		DS
Garage services	E	158	2014		DS
Tool manufacturers	E	158	2014		DS
Brewers	E	158	2014		DS
Car engine tuning and diagnostics	E	158	2014		DS
Precision engineers	W	111	2014		DS
Garage services	E	184	2014		DS
Paint and varnish stripping	E	158	2014		DS
Garage services	E	184	2014		DS
Sheet metal work	E	184	2014		DS
Garage services	E	140	2014		DS
Metal spinners	E	139	2014		DS
Spraying – paint and coatings	E	136	2014		DS
MOT testing centre	SW	214	2014		DS
Plastics – injection moulding	S	50	2014		DS
Glass production	E	42	2014		DS
Printers	W	182	2014		DS
Engineers	E	201	2014		DS
Precision engineers	W	173	2014		DS
Commercial vehicle bodybuilders and repairers	S	60	2014		DS
Sheet metal work	SW	62	2014		DS
Precision engineers	E	97	2014		DS
Dry cleaners	E	97	2014		DS
Garage services	SE/S	70/74	2014		DS
Joinery manufacturers	NE	230	2014		DS
Car body repairs	E	158	2014		DS
Plastic products – manufacturers	SW	131	2014		DS
Garage services	E	97	2014		DS
Precision engineers	E	158	2014		DS
Tool design and manufacturers	E	158	2014		DS
Metal products – fabricated	E	187	2014		DS
Garage services	E	187	2014		DS
Control panel manufacturers	E	187	2014		DS
Plastics – injection moulding	E	124	2014		DS
Plastic product – manufacturers	W	153	2014		DS
Photocopiers	W	190	2014		DS
Metal finishing services	SW	181	2014		DS
Sheet metal work	SW	214	2014		DS
Garage services	W	215	2014		DS
MOT testing centre	NE	239	2014		DS
Plastic products – manufacturers	E	237	2014		DS

Table 7.1. Summary of Potential Contamination Sources

Sources/Environmental Impact	Direction ¹	Distance (m)	Date Range		Data Origin
			From	To	
Boatbuilders and repairs	SW	243	2014		DS

Notes: Data Origin: - HM=Historic Maps; DS=Data Sheets; GM= Geological Maps ¹ For on-site relative to the centre of the site. The activities reported in the Envirocheck report that are not listed in the table are either (i) operating according to environmental guidance (i.e. environmental permitting or IPPC) therefore may not be considered as source of contamination, (ii) remote from the site or (ii) not located up gradient of the site therefore have not direct impact on identified receptors.

Section 8 Preliminary Conceptual Site Model

8.1 General

Environment Agency guidance provided in CLR11 indicates the Conceptual Site Model should identify those contaminants, pathways and receptors which are 'likely' to represent an 'unacceptable' risk either to human health or the surrounding environment. The following sections present potential contaminants and receptors based on this desktop study. Pathways have been established on reasonable scientific knowledge of the behaviour of the contaminants in the ground.

8.2 Sources of Contamination

From the study of the Landmark Envirocheck Report and Site Walkover the Phase I Desk Study has assessed and outlined potential contaminative sources (Table 7.1). Initial assessment of the likelihood each contaminative source poses a hazard to the site are considered in Sections 8.3.1 - 8.3.3.

8.2.1 On-Site Potential Contamination Sources

Map evidence, study of Landmark Envirocheck Report and Site Walkover showed the following potentially contaminative sources, given in Table 8.1.

Table 8.1. On-Site – Potentially Contaminative Sources

Sources	Direction ¹	Likelihood	
		Likely	Unlikely ¹
Alluvium – soil gas risk	-	✓	

Notes: ¹ Relates to the centre of the site. ² Sources are marked as 'Unlikely' if the hazard to the site was considered negligible. These considerations are based on type of contamination, age of source and anticipated significance.

8.2.2 Off-Site Potential Contamination Sources

Map evidence, study of Landmark Envirocheck Report and Site Walkover showed the following potentially contaminative sources, given in Table 8.2.

Table 8.2. Off-Site – Potentially Contaminative Sources

Sources	Direction	Distance (m)	Likelihood	
			Likely	Unlikely ¹
Portsmouth Water Works with engine houses and reservoirs	N	20-80	✓	
Tannery	NW	10	✓	
Washing Factory	E	10	✓	
Workhouse	NE	200		✓
Chamois Leather Works	E	10	✓	
Nurseries	W	150		✓
Parchment Works	NE	180		✓
Allotment gardens	N	150		✓
Brewery	NW	220		✓

Table 8.2. Off-Site – Potentially Contaminative Sources

Sources	Direction	Distance (m)	Likelihood	
			Likely	Unlikely ¹
Tanks – Portsmouth Water Works	NW	150	✓	
Works: Foundry, Electronics Factory, Engineering works, Depot	S	50	✓	
Works: Plastics Factory, Engineering works, Warehouse, Sheet Metal warehouse	SE	200		✓
Laundry	NW	250		✓
Works/Builders Yard	NE	180		✓
Manufacturers – roller shutters	W	98		✓
Tyre dealers	SE	123		✓
Garage services	E	158		✓
Tool manufacturers	E	158		✓
Brewers	E	158		✓
Car engine tuning and diagnostics	E	158		✓
Precision engineers	W	111		✓
Garage services	E	184		✓
Paint and varnish stripping	E	158		✓
Garage services	E	184		✓
Sheet metal work	E	184		✓
Garage services	E	140		✓
Metal spinners	E	139		✓
Spraying – paint and coatings	E	136		✓
MOT testing centre	SW	214		✓
Plastics – injection moulding	S	50	✓	
Glass production	E	42	✓	
Printers	W	182		✓
Engineers	E	201		✓
Precision engineers	W	173		✓
Commercial vehicle bodybuilders and repairers	S	60	✓	
Sheet metal work	SW	62	✓	
Precision engineers	E	97		✓
Dry cleaners	E	97	✓	
Garage services	SE/S	70/74		✓
Joinery manufacturers	NE	230		✓
Car body repairs	E	158		✓
Plastic products – manufacturers	SW	131		✓
Garage services	E	97	✓	
Precision engineers	E	158		✓
Tool design and manufacturers	E	158		✓
Metal products – fabricated	E	187		✓
Garage services	E	187		✓
Control panel manufacturers	E	187		✓
Plastics – injection moulding	E	124		✓
Plastic product – manufacturers	W	153		✓
Photocopiers	W	190		✓

Table 8.2. Off-Site – Potentially Contaminative Sources

Sources	Direction	Distance (m)	Likelihood	
			Likely	Unlikely ¹
Metal finishing services	SW	181		✓
Sheet metal work	SW	214		✓
Garage services	W	215		✓
MOT testing centre	NE	239		✓
Plastic products – manufacturers	E	237		✓
Boatbuilders and repairs	SW	243		✓

Notes: ¹ Sources are marked as 'Unlikely' if the hazard to the site was considered negligible. These considerations are based on type of contamination, age of source, anticipated significance and taking account of the source distance from the site.

8.2.3 Potential Contamination

From the Risk Assessment in Tables 8.1 & 8.2, the main groups of contaminants are presented in Table 8.3.

Table 8.3. Potential Contaminants

Contaminants/Chemical Property for Testing ¹		Potential Contaminative Sources	Hazard
P1	Ammonia		x
P2	Asbestos		x
P3	De-icing agents, fire-fighting chemical		x
P4	Herbicides		x
P5	Metals and semi-metals (e.g. Arsenic, Chromium)	Works, Factories and Manufacturers, Contemporary Trade directory sources, Historical sources	
P6	Non-chlorinated solvents	Dry Cleaners, Works	
P7	Organic compounds (e.g. PAHs and TPHs)	Works, Factories and Manufacturers, Contemporary Trade directory sources, Historical sources	
P8	Organic solvents (e.g. chlorinated solvents)		x
P9	Polychlorinated Biphenyl (PCBs)		x
P10	Sulphate		x
P11	Pathogens		x
P12	Soil Gas	Alluvium	

Notes: ¹ Based on DOE industrial profiles or on knowledge of the processes involved in the activity carried out on site. P=Properties; In conjunction with the chosen chemical properties, all soils must be tested for pH and SOM/TOC.

8.3 Potential Pathways

A pathway is a route or routes by which a receptor is exposed to a contamination source. Pathways can also determine the likelihood of the contamination source contacting a receptor.

Anthropogenic (or artificial) pathways for contaminant migration can be present in the form of land drains etc. Leaking sewage supply pipes and site drainage could also provide pathways for potential contaminant migration. Granular backfill to trenches for cables, gas pipes, water pipes etc. can also provide pathways for movement of mobile contaminants and contaminated groundwater.

The 1:50,000 BGS Map showed the site to be located on bedrock of Lewes Nodular Chalk Formation, with overlying superficial deposits of Alluvium, Head Deposits, and River Terrace Deposits (undifferentiated). The groundwater vulnerability of the site was classified as an aquifer with soil class high (H)U.

The Lewes Nodular Chalk Formation would have a moderate to high permeability, dependant on the fines content, and therefore would be expected to act as a pathway. The Alluvium is likely to have a moderate permeability and therefore would be expected to act as a pathway. The Head Deposits, and River Terrace Deposits (undifferentiated) would have a low permeability, dependant on the fines content, and therefore would be expected to act as a pathway.

Therefore, the Lewes Nodular Chalk Formation, Alluvium, Head Deposits, and River Terrace Deposits (undifferentiated) were **expected** to act as a migration pathway for contaminants via the groundwater from on-site or off-site sources.

The groundwater flow direction was to the south towards a GSPZ abstraction well, therefore only sources in close proximity to the site boundary, within the GSPZ I, or up hydraulic gradient, to the north, are considered.

Table 8.4. On-Site Sources, Pathways and Potential Receptors

Type of Attack	Standard Exposure Pathways	Factors	Site Assessment		Risk To Potential Receptors			
			Likely	Unlikely	HH	BS	EF	Controlled water (SW, GW, SPZ & A)
Oral	Direct soil and dust ingestion	Contaminants & Soft landscaping areas	✓		✓			
	Consumption of home-grown produce	Contaminants & Gardens areas	✓		✓			
Dermal	Dermal contact	Contaminants & Soft landscaping areas	✓		✓			
Inhalation	Inhalation of dust (indoor and outdoor)	Contaminants & Soft landscaping areas	✓		✓			
	Inhalation of vapours (indoor and outdoor)	Volatile compounds & Soft landscaping areas	✓		✓			
	Inhalation of soil gases	Soil gases (e.g. CH ₄ and CO ₂) within 0-250m	✓		✓			
Physical	Fire and explosion ¹	UXO (e.g. Bombs or projectile sites) (0-250m) ²		x				
		Combustible material in soil		x				
		Soil gases within 0-250m	✓		✓	✓		
	Via anthropogenic pathways (services trenches)	Contaminants & Trenches or drainage onsite	✓			✓		✓
	Others physical pathways ³	Degradation of fills, blast... etc...		x				
Chemical	Location of service supply pipes in contaminated soils	Hydrocarbons & Pipes		x		✓		
	Direct contact of concrete with concrete aggressive soils	Sulphate, Acids & Concrete	✓			✓		
Others	Irradiation ⁴	Radon	✓		✓	✓		
		Radioactive materials		x				
		UXO within 0-250m		x				
	Via surface water runoff	Contaminants & Gradient (Area)	✓				✓	✓
	Migration downwards via granular soils	Contaminants & Drift: Principal/secondary	✓				✓	✓
	Migration downwards via permeable soils and bedrock	Contaminants & Bedrock: Principal/secondary	✓					✓
		Contaminants & Groundwater vulnerability: Principal/secondary	✓				✓	✓
	Plant uptake and phytotoxicity ⁵	Metallic contaminants	✓				✓	✓
		Soil gases within 0-250m	✓				✓	
	Plant uptake and ecotoxicological effects ⁶	Contaminants	✓				✓	✓

Notes: BS= Building Structures & services. EF= Ecological Features, Controlled water (SW= Surface Water, GW=Groundwater, SPZ=Source Protection Zone and A= Abstractions within 250m to the site), HH=Human Health, ✓ = Likely and x=Unlikely.

¹ Both underground fires and biodegradable may produce toxic or flammable gases; ² UXO= Unexploded Ordnance: Although risk is generally low in the UK, a risk assessment (i.e. using Find map for example) may be needed if an UXO is found onsite. A UXO risk assessment has not been carried out at the time of reporting, and no evidence of local bomb strike sites was noted during the Phase I Desk Study assessment. ³ Blast-furnace and steel-making slag may expand. Degradation of fills may cause settlement and voids in buried tanks and drums may collapse as corrosion occurs or under loading; ⁴ Radioactive materials emitting gamma rays that can be inhaled and absorbed through the skin and also cause a radiation response;

⁵ Prevention or inhibition of plant growth; ⁶ Contaminants in soil may affect microbial, animal and plant populations. Ecosystems or individual species on the site, in surface waters or areas affected by migration from the site may be indirectly affected.

Table 8.5. Off-Site Potential Pathways

Receptors	Off-Site Potential Pathways	Likely	Unlikely
Human Health	Migration via surface water runoff (Surface flow)		✓
Building Materials			
Human Health	Migration via air	✓	
Building Materials			
Groundwater	Migration via groundwater flows	✓	
Human Health			
Building Materials			

8.4 Potential Receptors

With respect to land contamination, potential receptors include human health, ecological features, controlled waters, and buildings & materials.

The presence of potential receptors has been evaluated from our understanding of the current and future land use of the site, an assessment of surrounding land uses and currently available information pertaining to the site.

The assessment for potential receptors at the site is shown in Table 8.6.

Table 8.6. Potential Receptors

Potential Receptor		Present	
		Likely	Unlikely
Human Health	Future users of the site	✓	
	Visitors to the site	✓	
	Construction workers on site	✓	
	Service and maintenance workers	✓	
	Site neighbours and wider public	✓	
Groundwater/Controlled Waters	Groundwater/Future Potable Water Supply	✓	
	Surface Water	✓	
Buildings & Materials	Construction materials	✓	
	Buildings and confined spaces	✓	
Ecosystems	Flora and fauna in surface water	✓	

8.5 Preliminary Risk Assessment

A preliminary risk assessment has been undertaken relating to the potential proposed development based on a qualitative assessment of the likely presence of a pollutant linkage. A pollutant linkage is the relationship between a contaminant source, a pathway and a receptor. Unless all three elements of a pollutant linkage are present, a risk is not considered to exist. Each of the three elements was considered in Sections 8.3, 8.4 & 8.5.

The approach adopted was to screen the site based on assigning a risk category. The preliminary risk assessment is presented in Table 8.7 with the risk assessment criteria attached to this report (Appendix E).

Table 8.7. Risk Assessment

Environs	Direction	Distance (m) ¹	Pathway	Receptor	Risk ¹
Alluvium – soil gas risk	-	0	✓	✓	Very Low
Portsmouth Water Works with engine houses and reservoirs	N	20-80	✓	✓	High
Tannery	NW	10	✓	✓	High
Washing Factory	E	10	✓	✓	High
Chamois Leather Works	E	10	✓	✓	High
Tanks – Portsmouth Water Works	NW	150	✓	✓	High
Works: Foundry, Electronics Factory, Engineering works, Depot	S	50	✓	✓	High
Plastics – injection moulding	S	50	✓	✓	Medium
Glass production	E	42	✓	✓	Medium
Commercial vehicle bodybuilders and repairers	S	60	✓	✓	Low
Sheet metal work	SW	62	✓	✓	Low
Dry cleaners	E	97	✓	✓	Low
Garage services	E	97	✓	✓	Low

Note: ¹ Approximately from boundary of the site.

The classification tables are presented in Appendix E are modified from, 'Contaminated land risk assessment: A guide to good practice, 2001, CIRIA C552'.

8.6 Preliminary Conceptual Site Model

The preliminary conceptual site model, including linkages that require further actions is presented in Table 8.8.

Table 8.8. Preliminary Conceptual Site Model and Risk assessment methodology

Linkage No	Potential Contaminants Identified (Table 8.3)	Pathway (See Tables 8.4 & 8.5)	Receptor (See Table 8.6)	Risk Assessment Methodology (plus anticipated quantitative risk assessment methods)	Site specific settings	Risk Classification: Based on Desk Study	Pollutant Linkage & Action Required
1	P5-7	e.g. Uptake (root and stomata), ingestion, inhalation and dermal absorption by animal)	Ecological features (i.e. Flora and Fauna)	Presence of SSSI, Museum, Natural reserves and others within 0- 250m to the site. Use EA Science Report	Lakes noted across the site area – potential contaminants may pose a risk to onsite ecological system.	Likely to be low	The view of the regulatory authority must be sought. Further action: Phase II intrusive site investigation
2	P5-7	e.g. Chemical attack	Building structures/services	Soil testing & use BRE 2005 for risk assessment. Water UK (2014) for pipes. Use Anglian Water trigger for services risk assessment	Proposed foundations and services pipes to be used.	Likely to be low	Further action: Phase II intrusive site investigation
3	P5-7	e.g. Inhalation, ingestion and dermal contact	Human health Residents	Use CLEA for human risk assessment	Residential with plant uptake	Likely to be moderate	Further action: Phase II intrusive site investigation
			Human Health Workers	Assessment not within the scope of this Desk study (responsibility of building contractor). Ground workers should follow regulations on health and safety during development (HSE, 1991)	Workers and the general public should follow regulation on health and safety during development (HSE, 1991)	Likely to be low	Follow HSE procedures
4	P5-7	e.g. Leaching (direct precipitation, overland flow and through flow)	Shallow groundwater/ Surface Water	Assessment to be carried out based on distance from watercourse and direction of flow – Consider use of R&D 20 publication for risk assessment	Surface water noted onsite as well as springs, and a GSPZ I abstraction borehole.	Likely to be moderate	Further action: Phase II intrusive site investigation
5	P5-7	e.g. Leaching (direct precipitation, overland flow, through and groundwater flow)	Deep groundwater	Undertake groundwater or leachate testing depending on site specific ground conditions. – Consider use of R&D 20 publication for risk assessment if contamination is identified.	Site is located on Principal Aquifer and GSPZ I.	Likely to be moderate	Further action: Phase II intrusive site investigation
6	P12	e.g. Through fissures, shafts, high permeability strata and Inhalation by human	Human and Building Structures	Current or former Landfill sites within 0-250m to the site. Assess nature/age/size of site for Risk Assessment. Use CIRIA 149 & 665 to assess need for gas protection measures where necessary following ground gas testing	Alluvium noted onsite. Radon Gas risk noted on site. If waste water if treated onsite, a risk of gas emission from this process may exist.	Likely to be very low.	Further action: Gas monitoring should be considered if primary site investigations show significant organic matter in the ground, and also because of the water treatment plant in the vicinity of the site.

Note: HSE= Health and Safety Executive, SPZ= Source Protection Zone and P=Property, P2 Asbestos, P5 Metals and semi-metals (e.g. Arsenic, Chromium), P6 Non-chlorinated solvents, P7 Organic compounds (e.g. PAHs and TPHs), P8 Organic solvents (e.g. chlorinated solvents), P9 Polychlorinated Biphenyl (PCBs), P10 Sulphate, P12 Soil Gas

The intrusive investigation may reveal on site sources of contamination that were not established by the Phase I Desk Study and Site Walkover that could modify the Conceptual Site Model.

Section 9 Recommendations

9.1 General

Based on the information obtained during the desk study and the preliminary conceptual site model derived for the site, an intrusive contaminated land investigation is required to determine actual pollution linkages and to assess the risk to the identified receptors.

The intrusive investigation may reveal on-site sources of contamination that were not established by the Phase I Desk Study and Site Walkover, and thus require modification of the conceptual model.

9.2 Impact of Construction Activities on Controlled Waters and Site Neighbours

A demolition and construction risk assessment must be undertaken and appropriate measures taken to mitigate against mobilisation and to monitor impact to groundwater and surface waters.

9.3 Proposed further Site Works

The proposal is a combined geotechnical and Phase II Intrusive Investigation (Table 8.10) in order to obtain further information as follows:

9.3.1 Phase II Intrusive Investigation

The Preliminary CSM allows for the identification of the test parameters relevant to the investigation, though this may require modification or addition from the findings of the intrusive investigation. Phase II intrusive site investigation will be carried out in order to investigate and assess pollutant linkages 2, 3 and 4 of the preliminary Conceptual Site Model presented in Table 8.8.

The works to be undertaken on the site would comprise (i) soil sampling that is appropriate to the potential sources and (ii) testing for the potential contaminants given in the CSM or other sources identified during the intrusive investigation.

9.3.2 Geotechnical site investigation

The purpose of the geotechnical investigation will be to obtain data regarding engineering properties of the soils to enable the design of foundations, pavements and drainage.

The works to be undertaken on the site would comprise (i) soil sampling, (ii) drilling boreholes with window sampler and percussion drilling rig at selected locations within the site and (iii) probing using either DPH or DPSH to permit the establish foundation design engineering parameters for foundation design.

Table 8.8. Proposed further works

Further works	Environmental Phase II intrusive site investigation	Geotechnical site investigation	General Purpose
Soil sampling	✓	✓	Take sampling for laboratory testing across the site
<i>In situ</i> or laboratory soils testing	✓		Determine the nature and extent of contamination across the site
		✓	Engineering parameters for foundation design
Generic and/ or site specific risk assessment	✓		Assess pollutant Linkages 1-6 (Table 8.8) based on current contaminated land guidance
Drilling boreholes with window sampler across the site	✓	✓	Determine the nature of the ground
Boreholes installation	✓	✓	1.If Tier 1 risk assessment for groundwater only shows on acceptable levels of contamination in groundwater, further groundwater testing and monitoring may be necessary. 2.If soil testing and site investigation show significant organic matter within the soil as a result of onsite Alluvium, or if waste water is treated onsite, gas monitoring may be considered. This is however unlikely.
Remediation	✓		If intrusive investigation and site specific risk assessment reveal that the site was contaminated
Soils testing for validation	✓		If remediation was carried out on site
Probing using either DPH or DPSH		✓	Establish foundation design and engineering parameters for foundation design

9.4 Discovery Strategy

There may be areas of contamination not identified during the course of the intrusive investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil; discolouration, or odours and emission. Upon discovery, advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Engineer and if appropriate the Local Authority must be informed.

These appendices complete this report:

Appendix A	County Series and Ordnance Survey Maps
Appendix B	Landmark Envirocheck Report
Appendix C	Site Sensitivity Maps
Appendix D	Site Photographs
Appendix E	Risk Assessment Criteria

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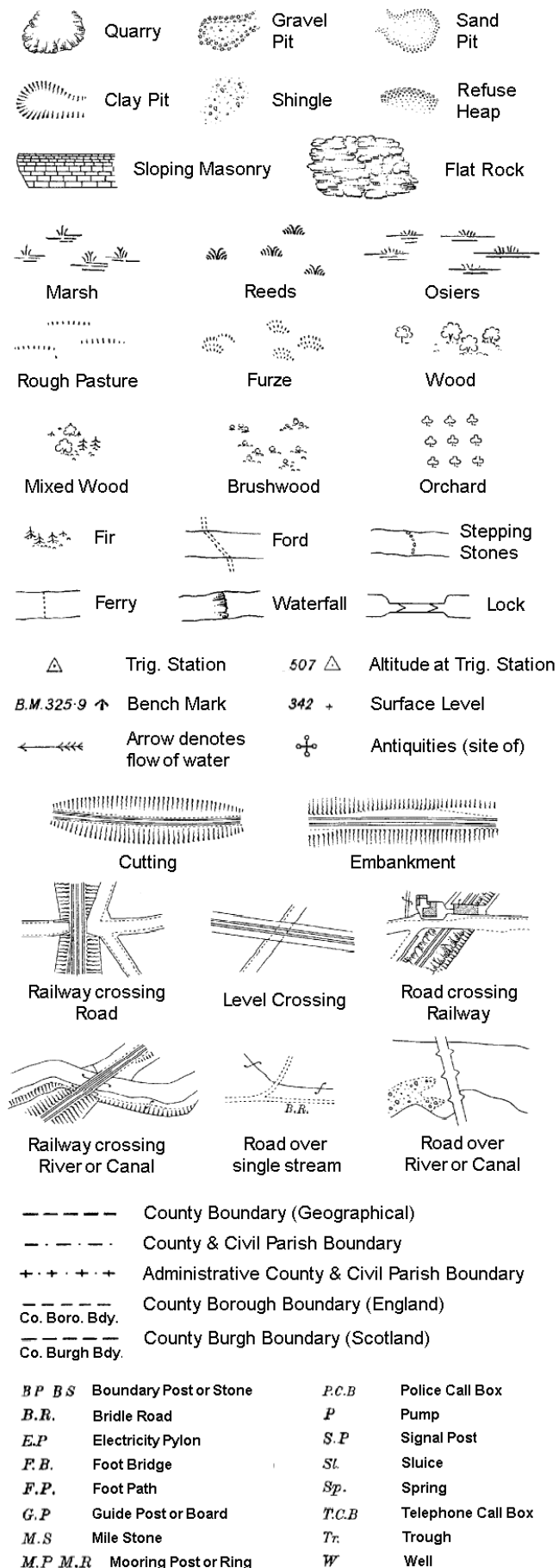


Eur Ing. R. B. Higginson B.Sc., PG. Dip., C.Eng. MICE., FGS.
Geotechnical Advisor

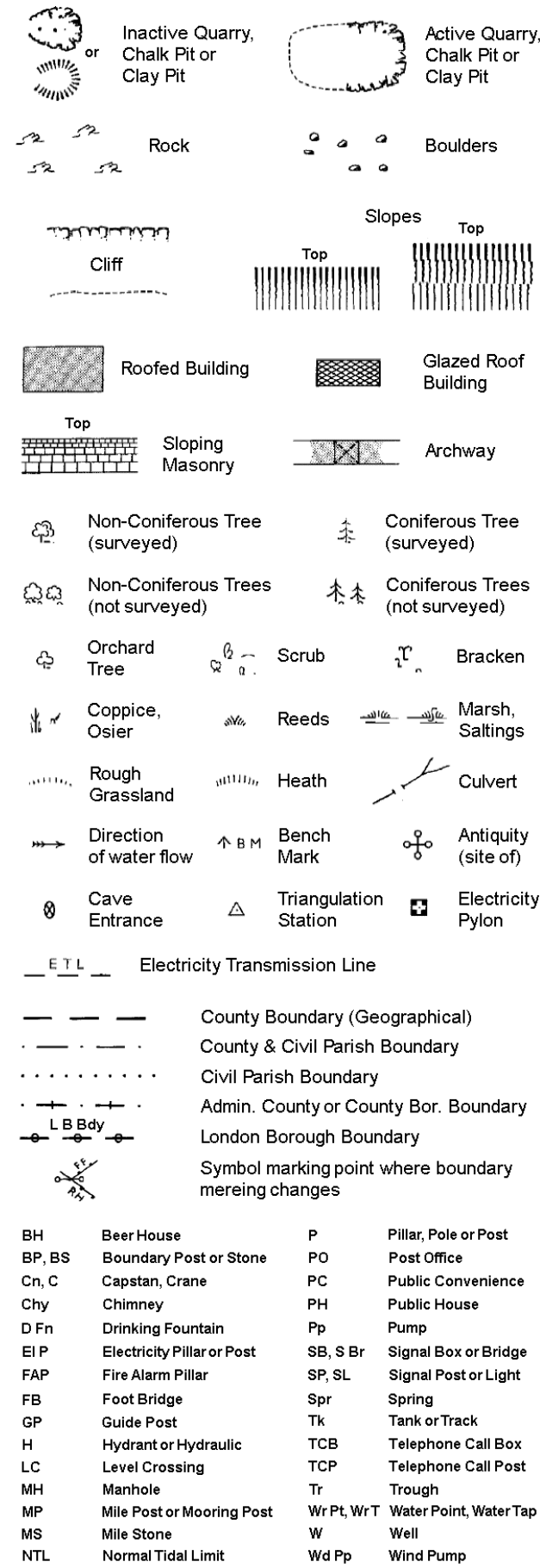
Appendix A
County Series and Ordnance Survey Maps

Historical Mapping Legends

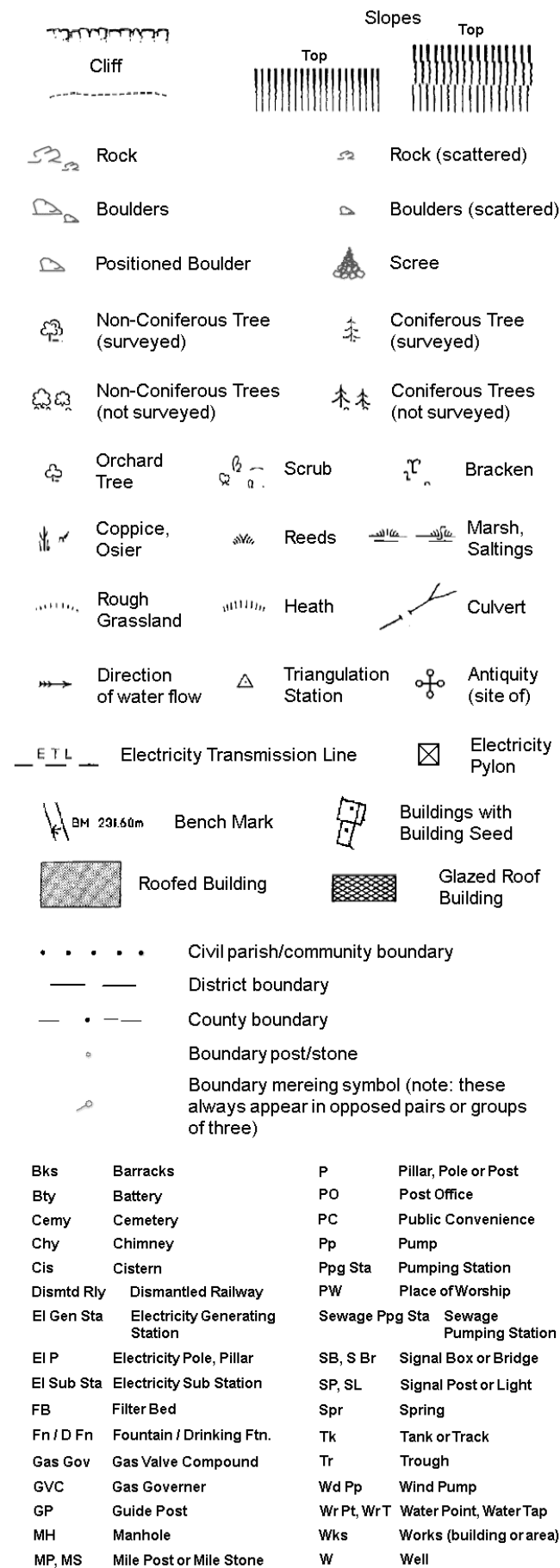
Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



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



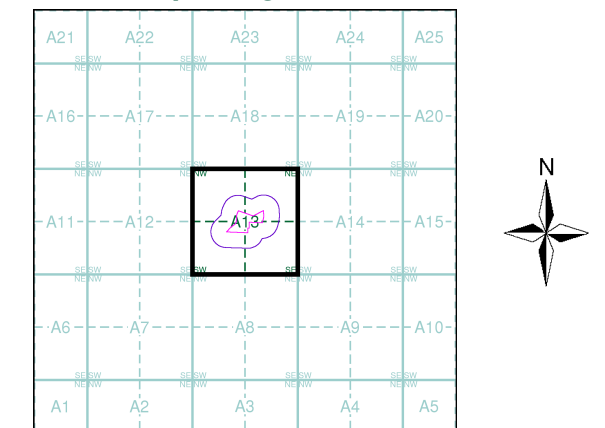
Large-Scale National Grid Data 1:2,500 and 1:1,250



Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Hampshire & Isle Of Wight	1:2,500	1866 - 1868	2
Hampshire & Isle Of Wight	1:2,500	1866 - 1868	3
Hampshire & Isle Of Wight	1:2,500	1867 - 1868	4
Hampshire & Isle Of Wight	1:2,500	1897	5
Hampshire & Isle Of Wight	1:2,500	1909	6
Hampshire & Isle Of Wight	1:2,500	1932	7
Additional SIMs	1:2,500	1953 - 1987	8
Ordnance Survey Plan	1:2,500	1954 - 1969	9
Ordnance Survey Plan	1:1,250	1959 - 1973	10
Ordnance Survey Plan	1:2,500	1961 - 1974	11
Ordnance Survey Plan	1:2,500	1969	12
Ordnance Survey Plan	1:1,250	1969 - 1989	13
Ordnance Survey Plan	1:1,250	1973	14
Supply of Unpublished Survey Information	1:2,500	1973	15
Supply of Unpublished Survey Information	1:1,250	1973	16
Additional SIMs	1:2,500	1984	17
Additional SIMs	1:1,250	1987 - 1989	18
Large-Scale National Grid Data	1:2,500	1993	19
Large-Scale National Grid Data	1:1,250	1993	20

Historical Map - Segment A13



Order Details

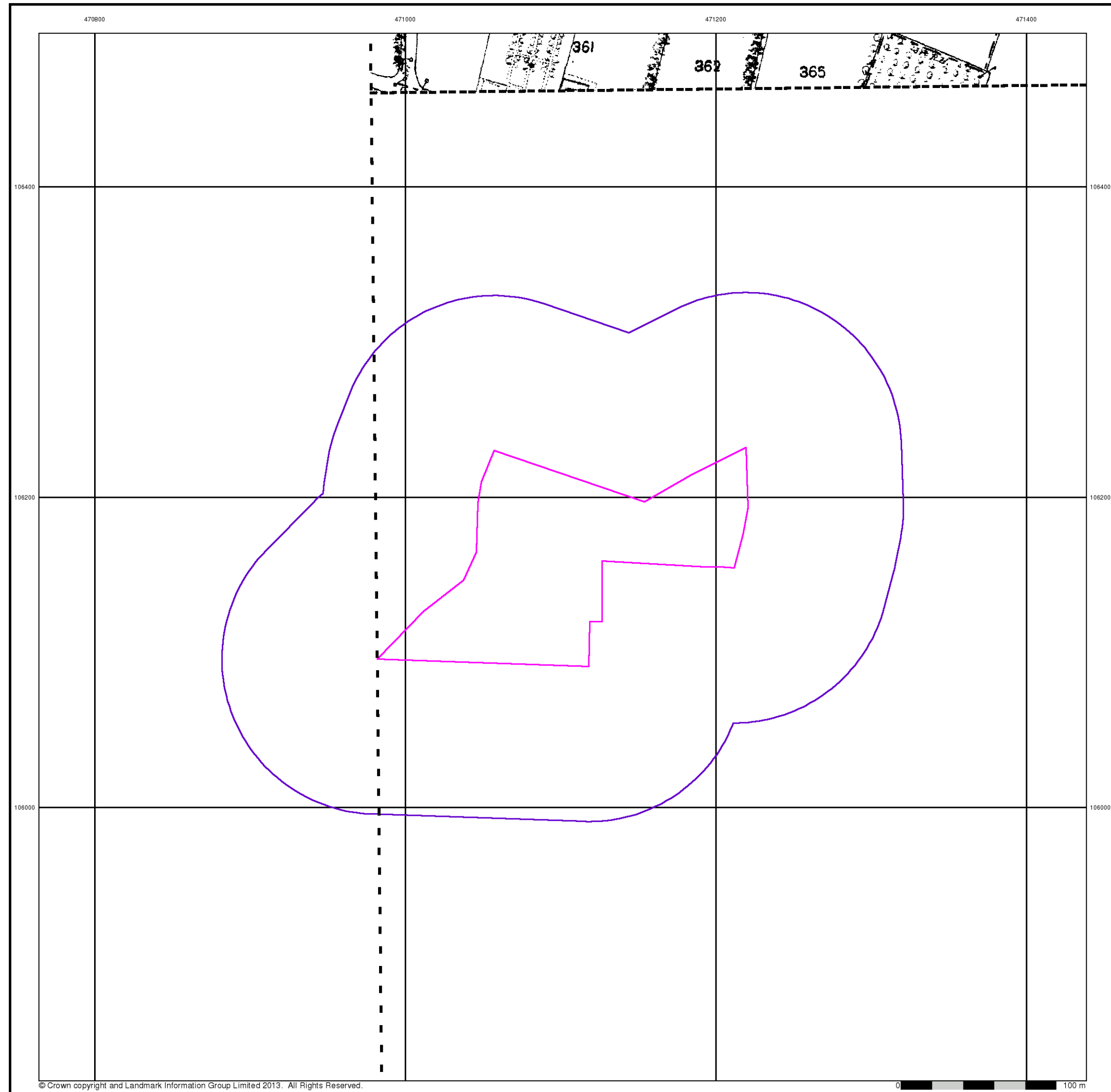
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

Land north of, Solent Road, HAVANT, Hampshire, PO9 1DQ



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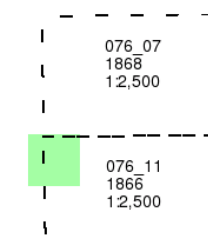
Hampshire & Isle Of Wight

Published 1866 - 1868

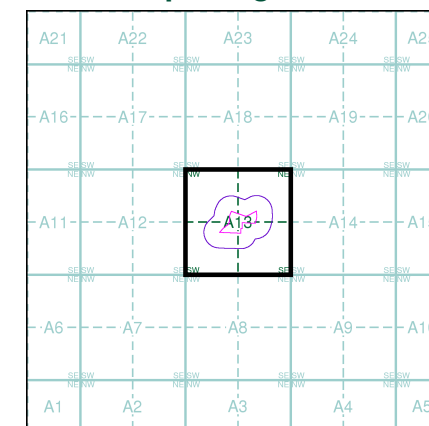
Source map scale - 1:2,500

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

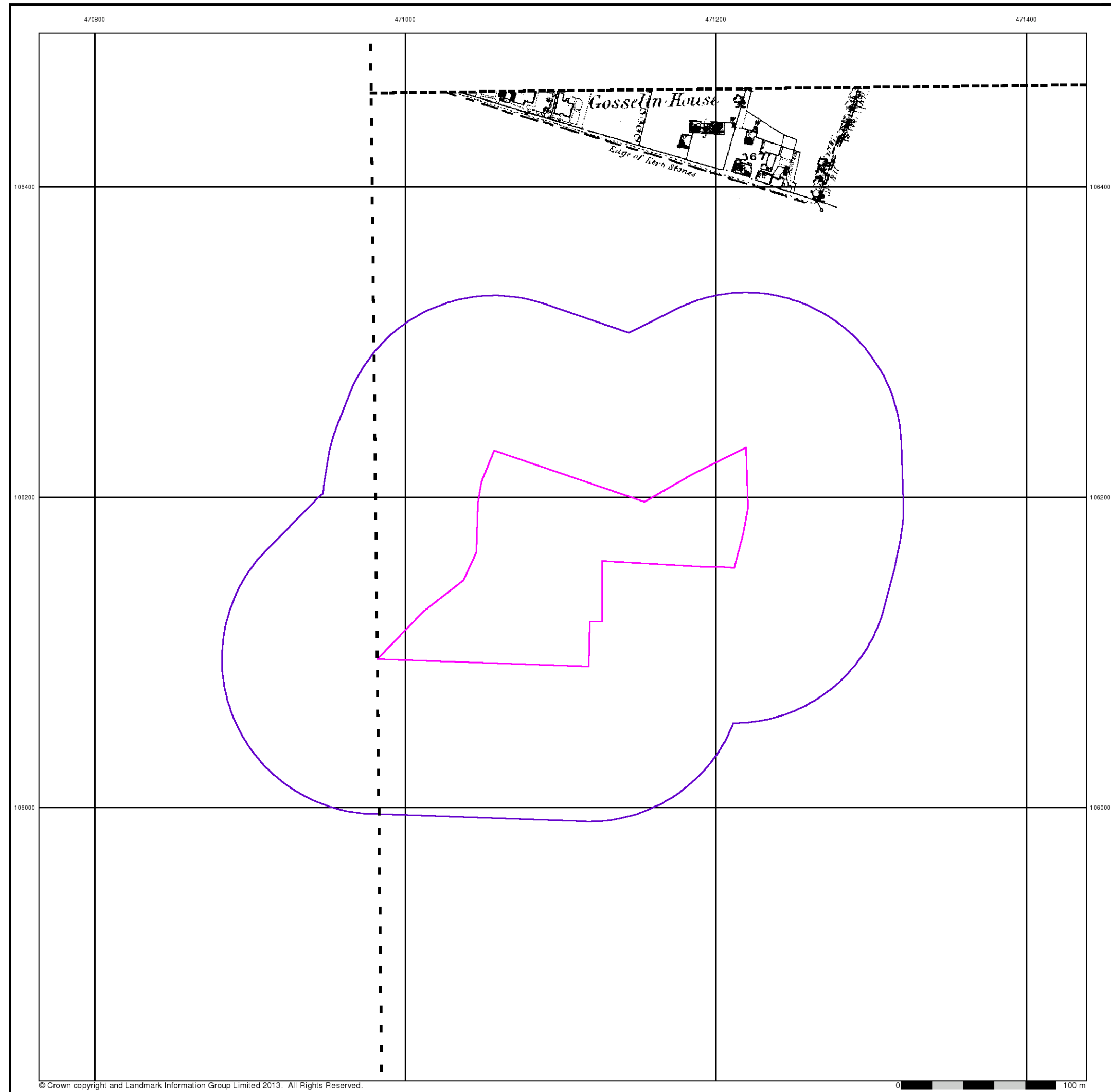
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
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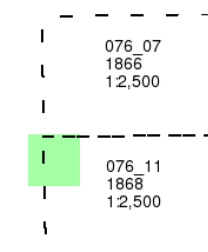
Hampshire & Isle Of Wight

Published 1866 - 1868

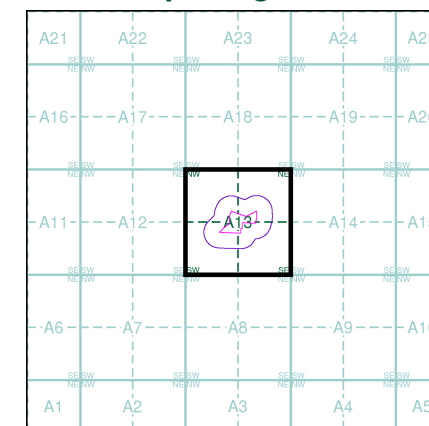
Source map scale - 1:2,500

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

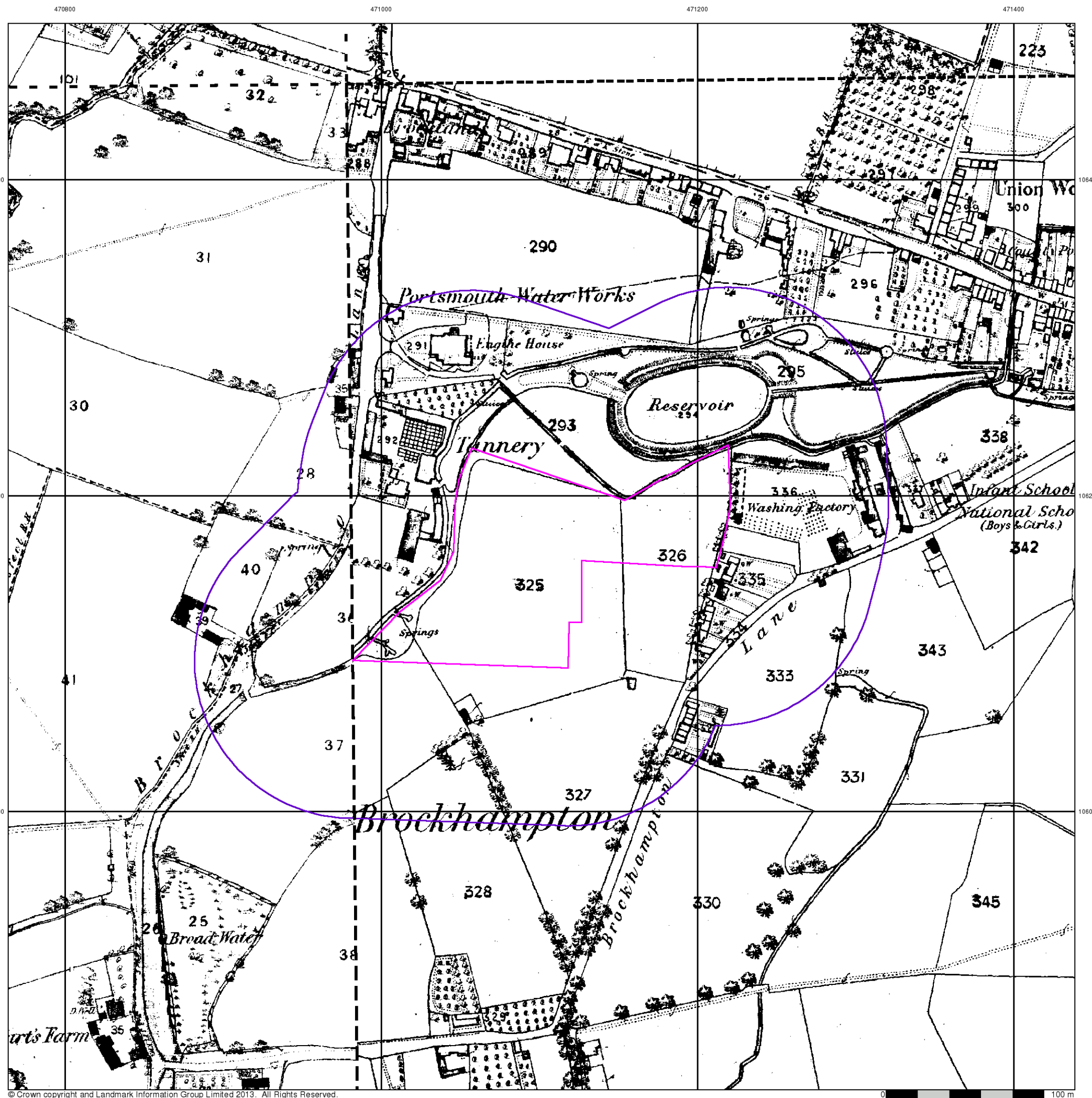
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

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Hampshire & Isle Of Wight

Published 1867 - 1868

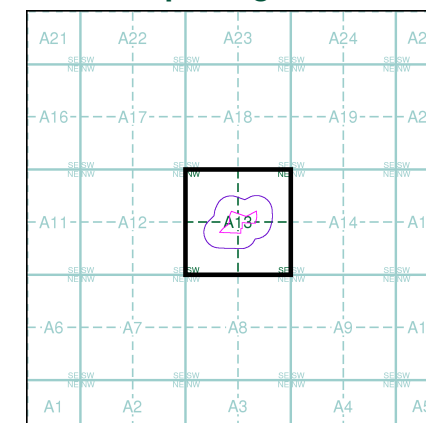
Source map scale - 1:2,500

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)

076_06 1868 1:2,500	076_07 1867 1:2,500
076_10 1868 1:2,500	076_11 1867 1:2,500

Historical Map - Segment A13

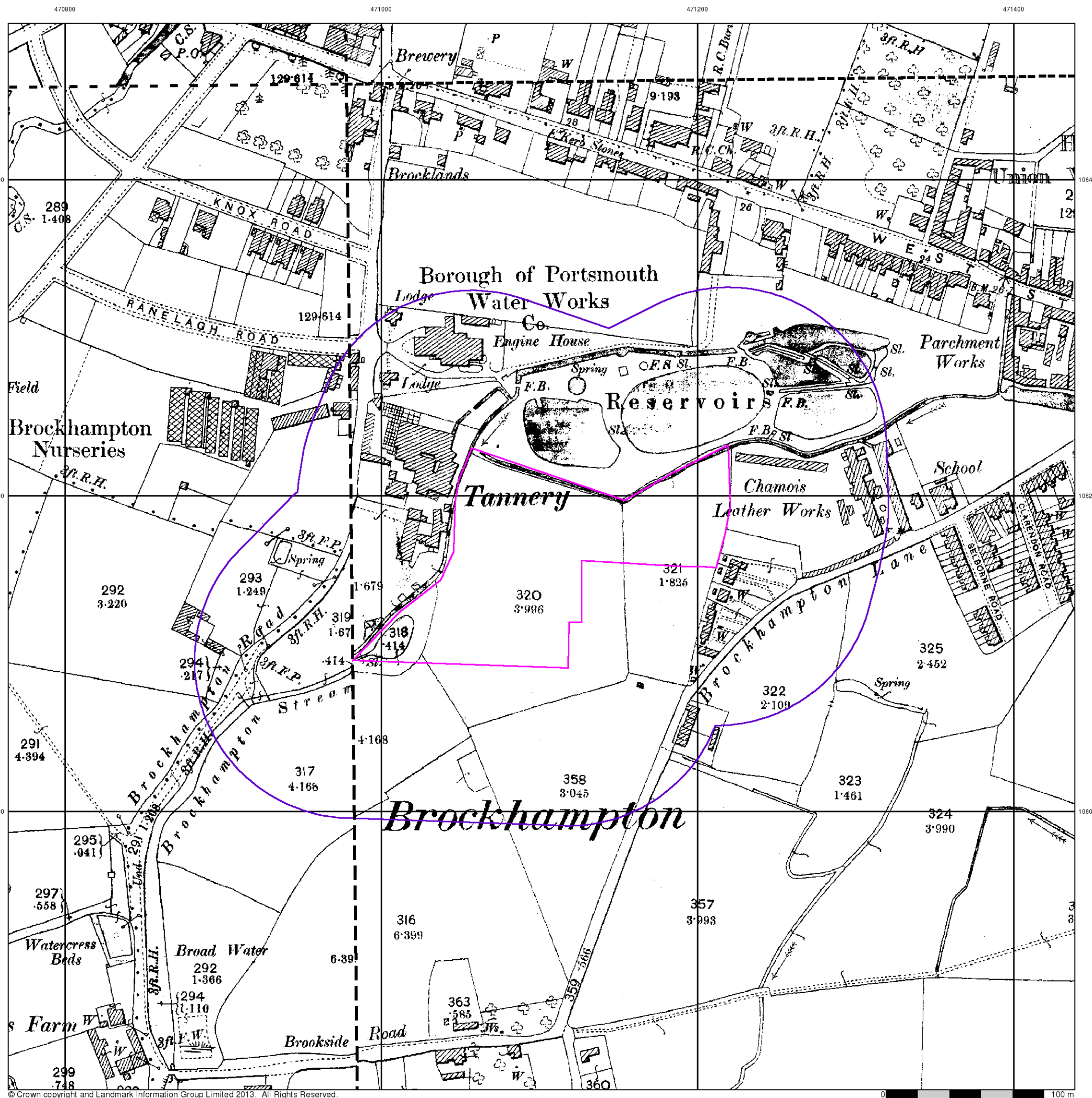


Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

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Hampshire & Isle Of Wight

Published 1897

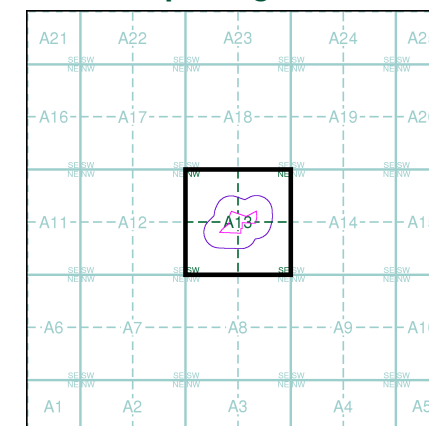
Source map scale - 1:2,500

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)

076_06 1897 1:2,500	076_07 1897 1:2,500
076_10 1897 1:2,500	076_11 1897 1:2,500

Historical Map - Segment A13

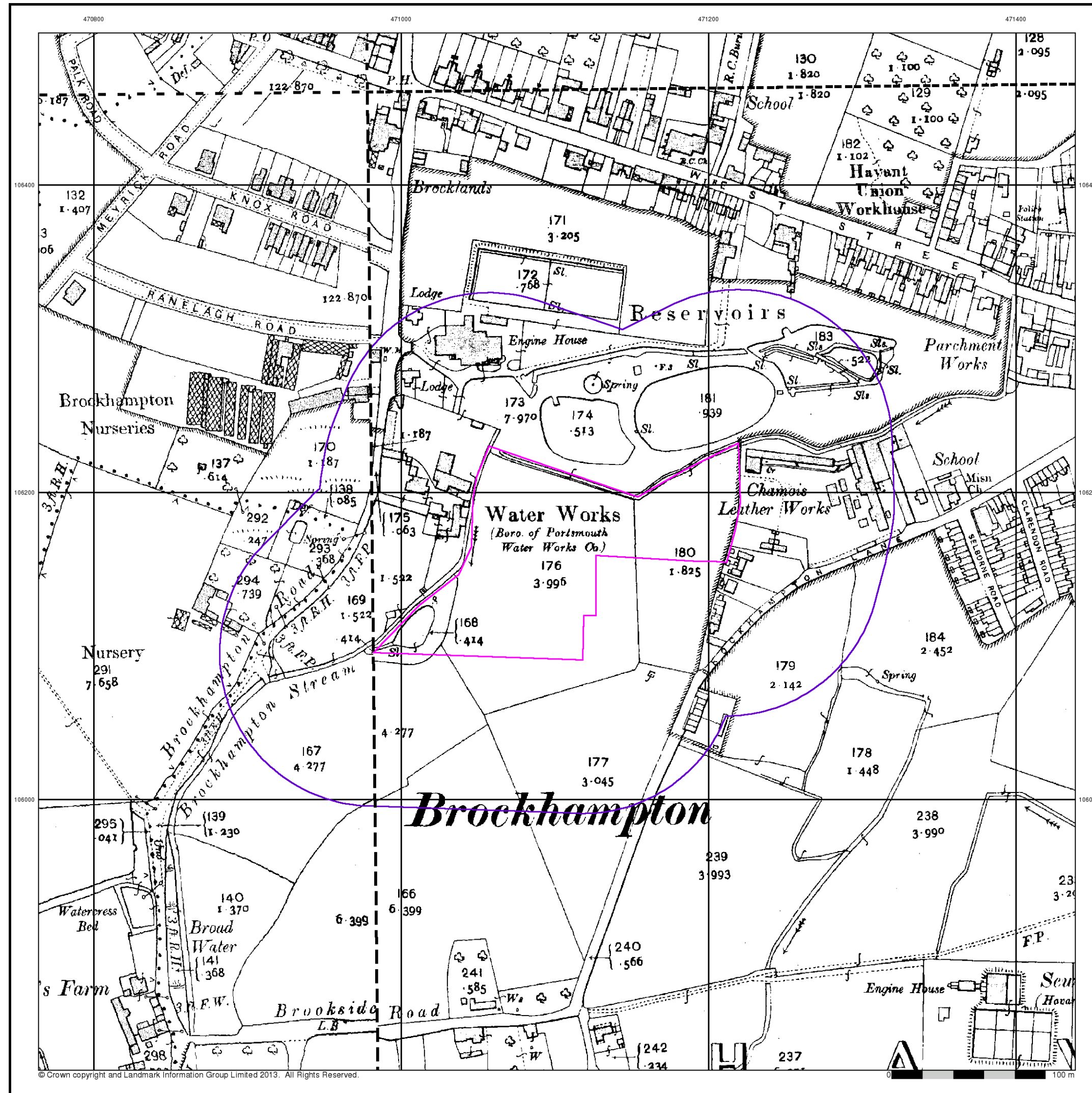


Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

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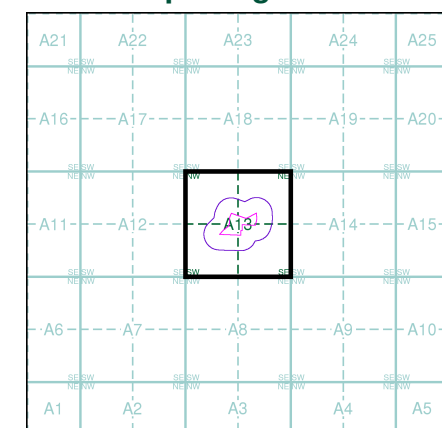


The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain.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

076_06 1909 1:2,500	076_07 1909 1:2,500
076_10 1909 1:2,500	076_11 1909 1:2,500

Historical Map - Segment A13



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

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Hampshire & Isle Of Wight

Published 1932

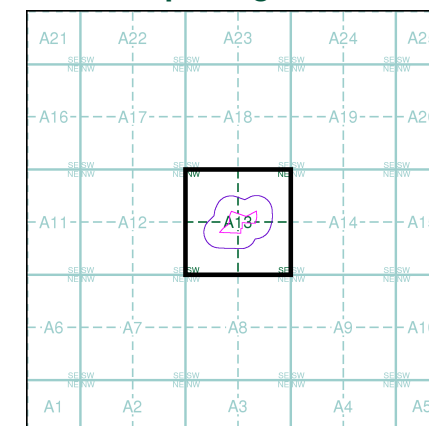
Source map scale - 1:2,500

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)

076_06 1932 1:2,500	076_07 1932 1:2,500
076_10 1932 1:2,500	076_11 1932 1:2,500

Historical Map - Segment A13



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

Land north of, Solent Road, HAVANT, Hampshire, PO9 1DQ



Additional SIMs

Published 1953 - 1987

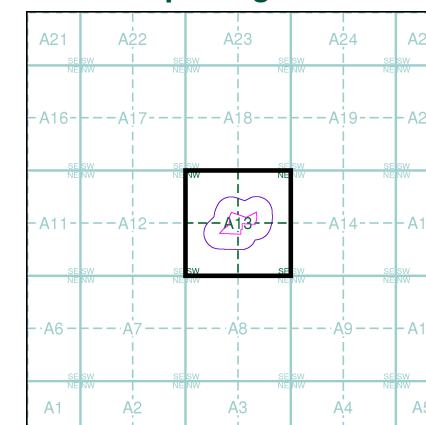
Source map scale - 1:2,500

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)

		SU7106 1953 1:2,500	
SU7005 1987 1:2,500		SU7105 1953 1:2,500	

Historical Map - Segment A13



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

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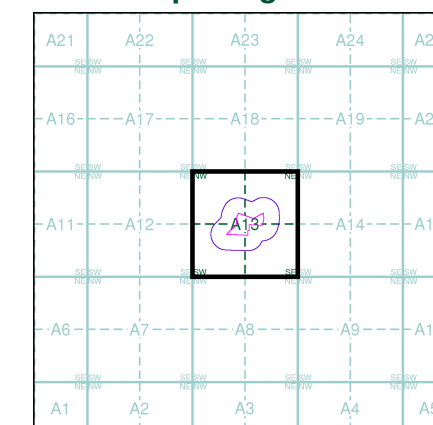
Ordnance Survey Plan
Published 1954 - 1969
Source map scale - 1:2,500

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)

SU7006 1954 1:2,500	SU7106 1961 1:2,500
SU7105 1969 1:2,500	

Historical Map - Segment A13



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

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Ordnance Survey Plan

Published 1959 - 1973

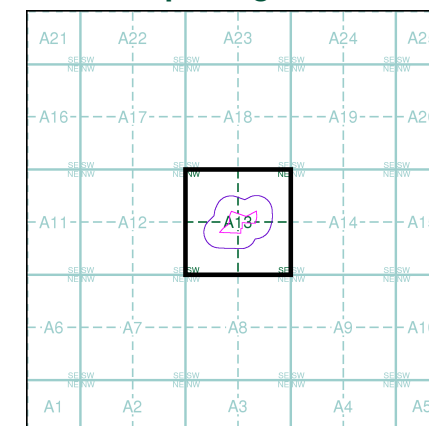
Source map scale - 1:1,250

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)

SU7006SE 1959 1:1,250	SU7106SW 1960 1:1,250
	SU7105NW 1973 1:1,250

Historical Map - Segment A13



Order Details

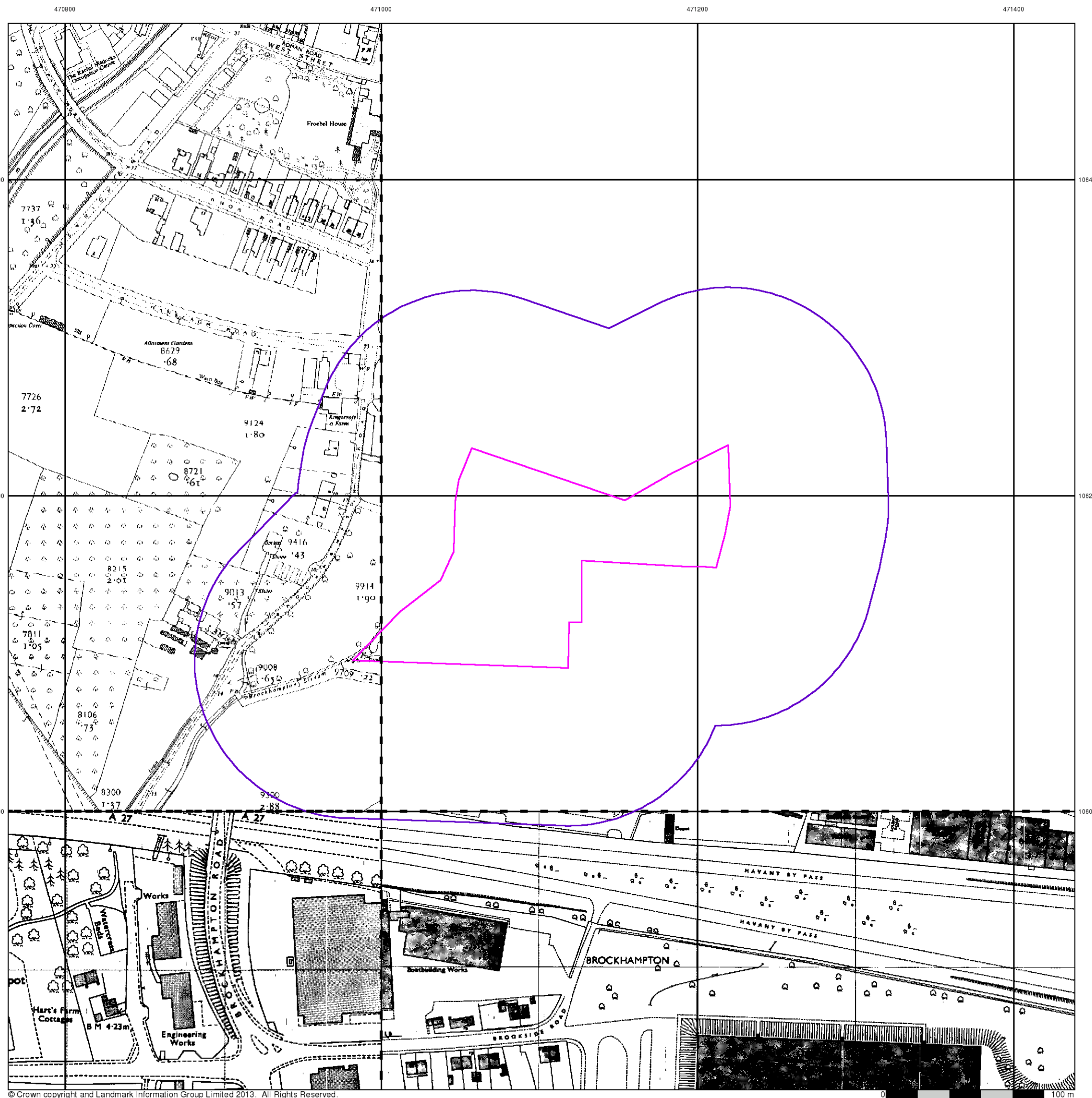
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

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Ordnance Survey Plan

Published 1961 - 1974

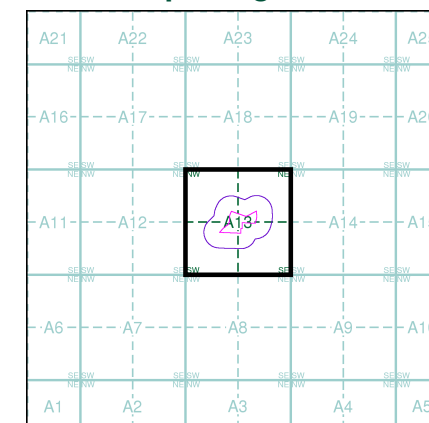
Source map scale - 1:2,500

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)

SU7006 1961 12,500	
SU7005 1974 12,500	SU7105 1974 12,500

Historical Map - Segment A13

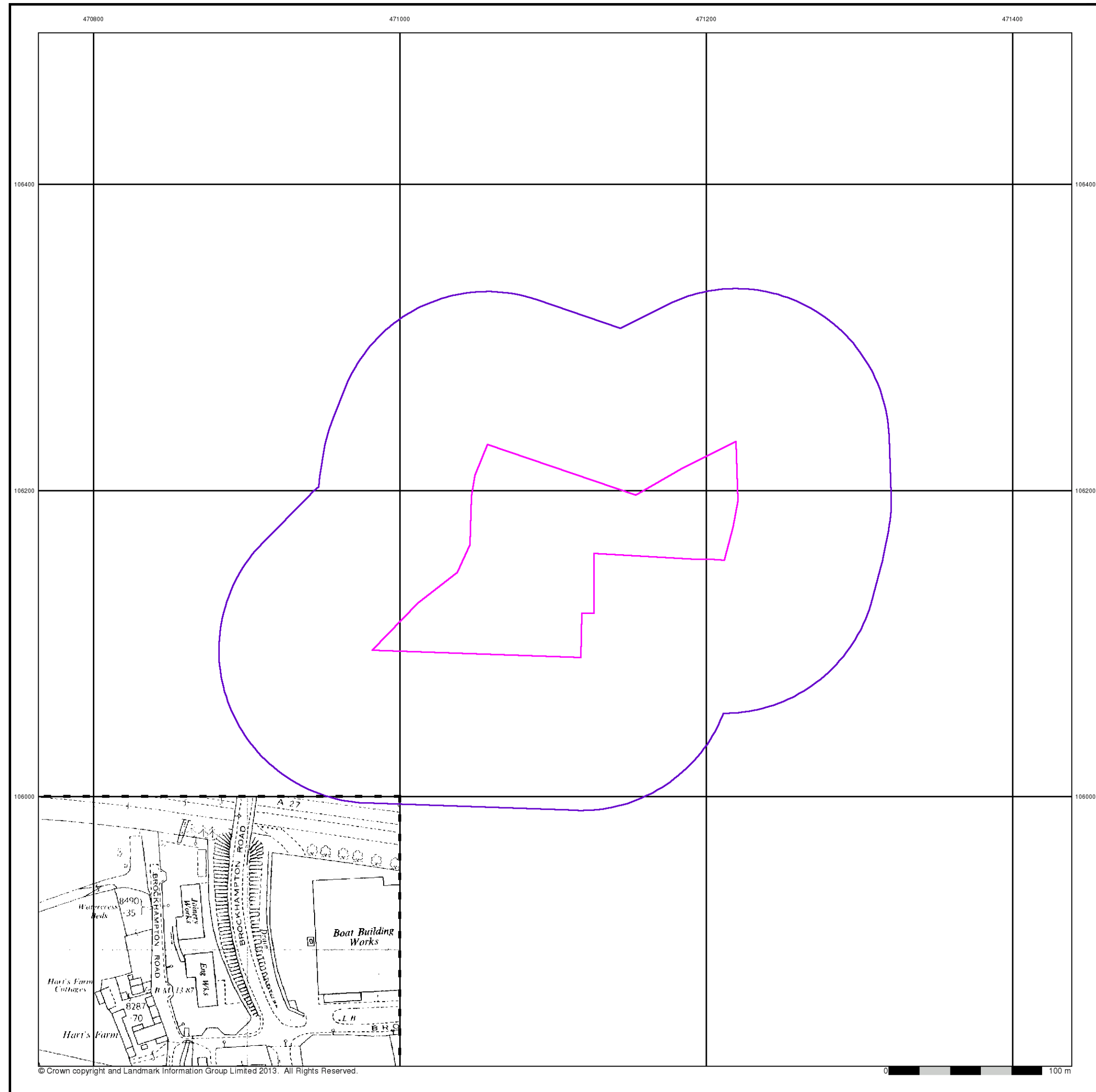


Order Details

Order Number: 56545315_1_1
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Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

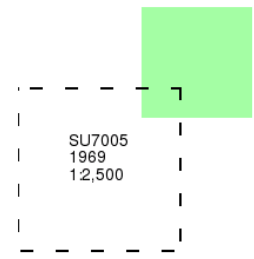
Land north of, Solent Road, HAVANT, Hampshire, PO9 1DQ



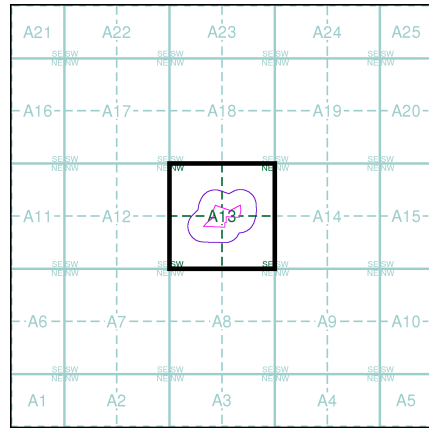
Ordnance Survey Plan
Published 1969
Source map scale - 1:2,500

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)

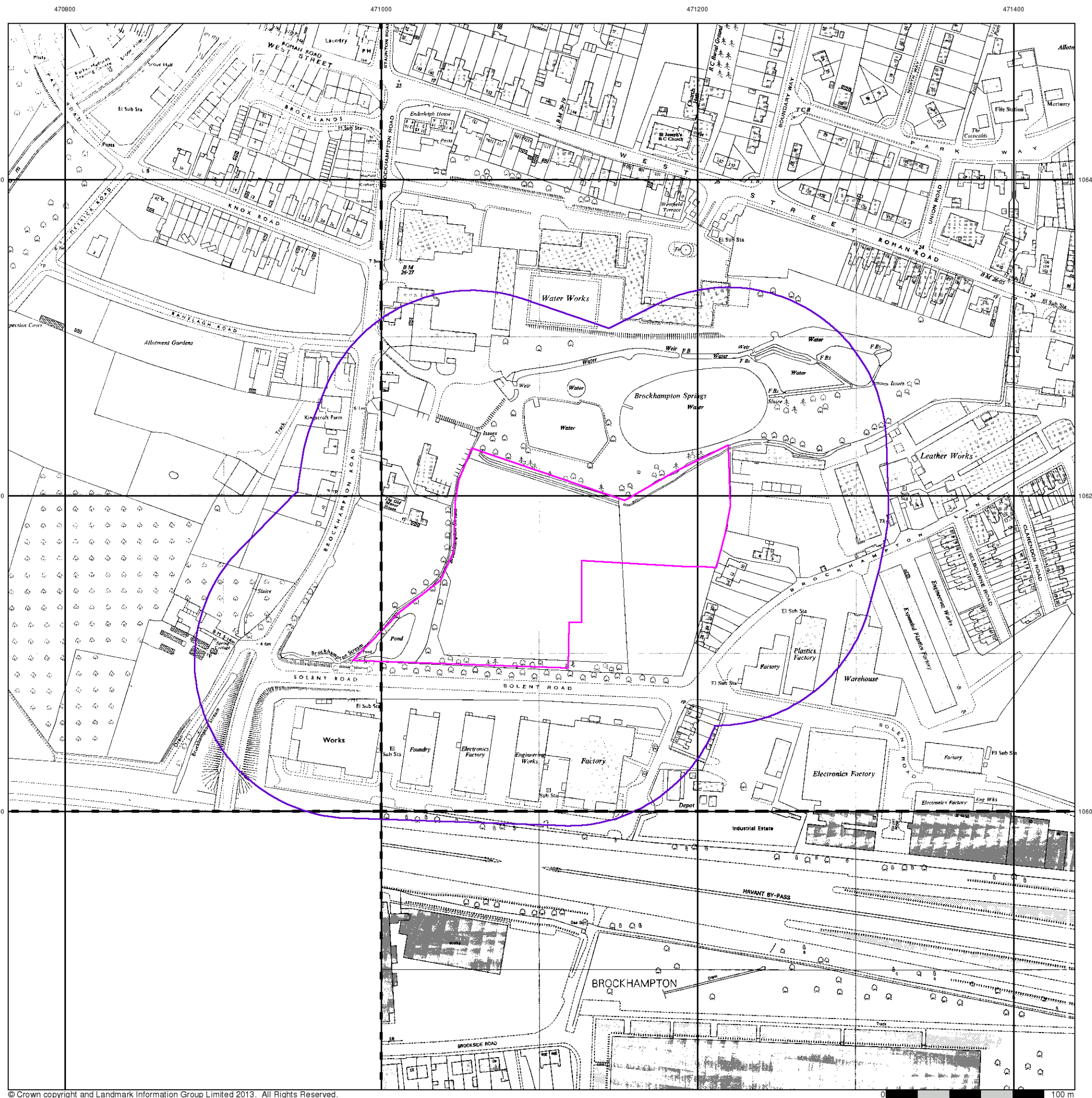


Historical Map - Segment A13



Order Details
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details
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Ordnance Survey Plan

Published 1969 - 1989

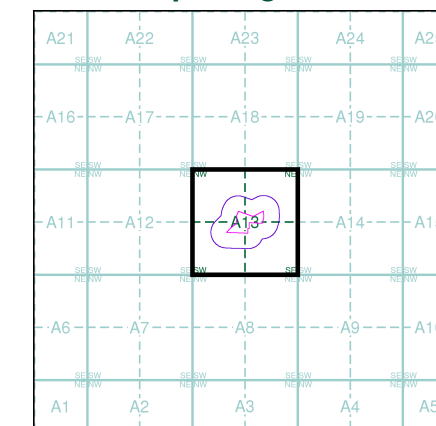
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Map Name(s) and Date(s)

SU7006SE 1969 1:1,250	SU7106SW 1969 1:1,250
	SU7105NW 1989 1:1,250

Historical Map - Segment A13



Order Details

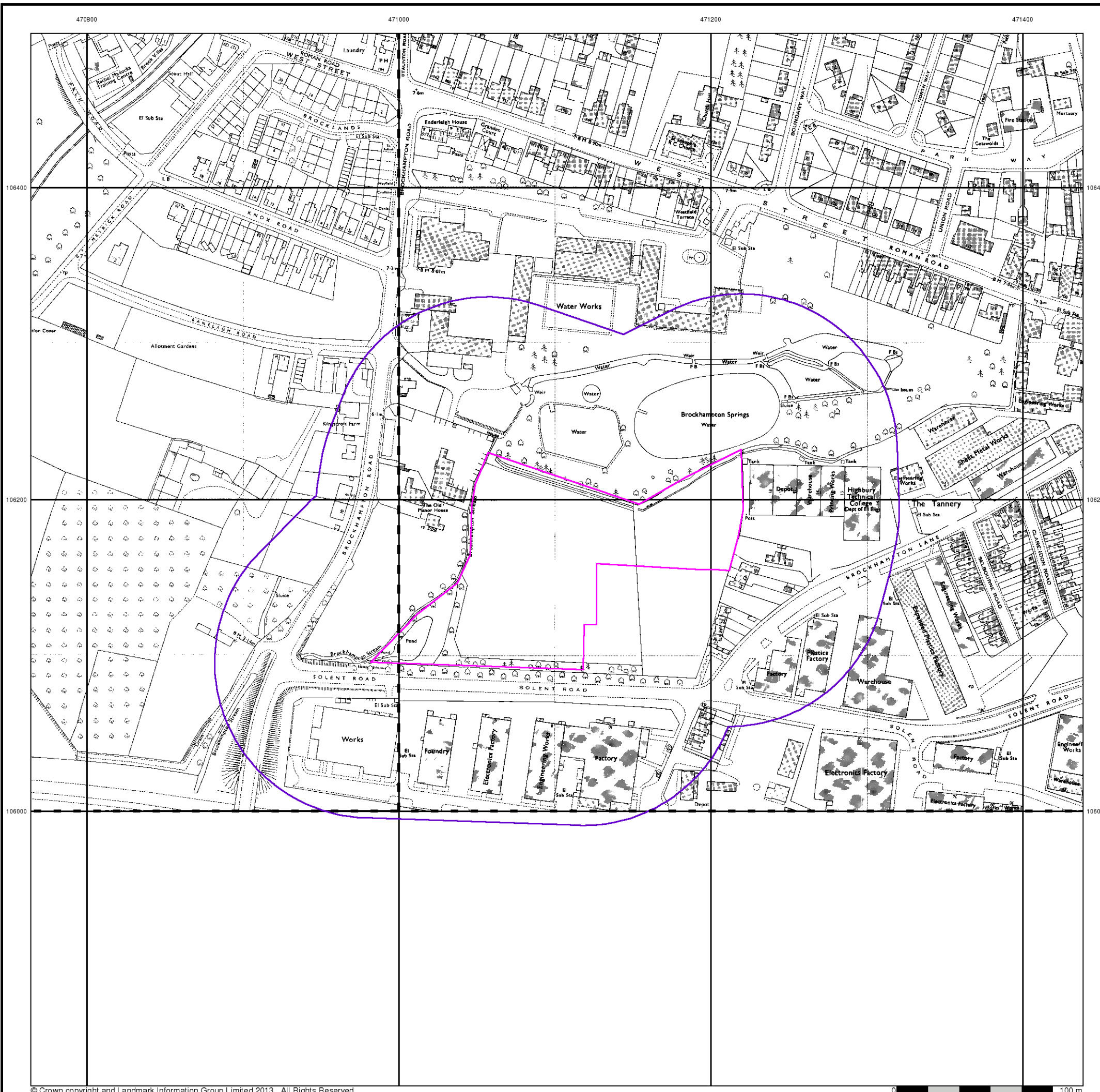
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Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

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Ordnance Survey Plan

Published 1973

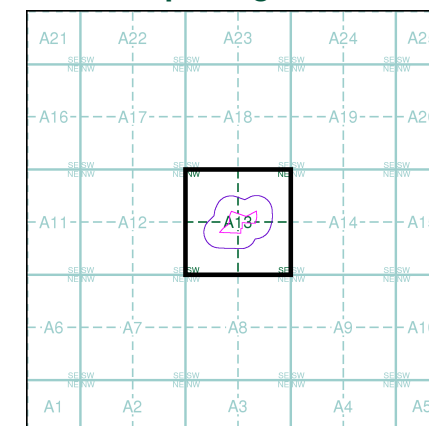
Source map scale - 1:1,250

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)

SU7006SE 1973 1:1,250	SU7106SW 1973 1:1,250
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Historical Map - Segment A13



Order Details

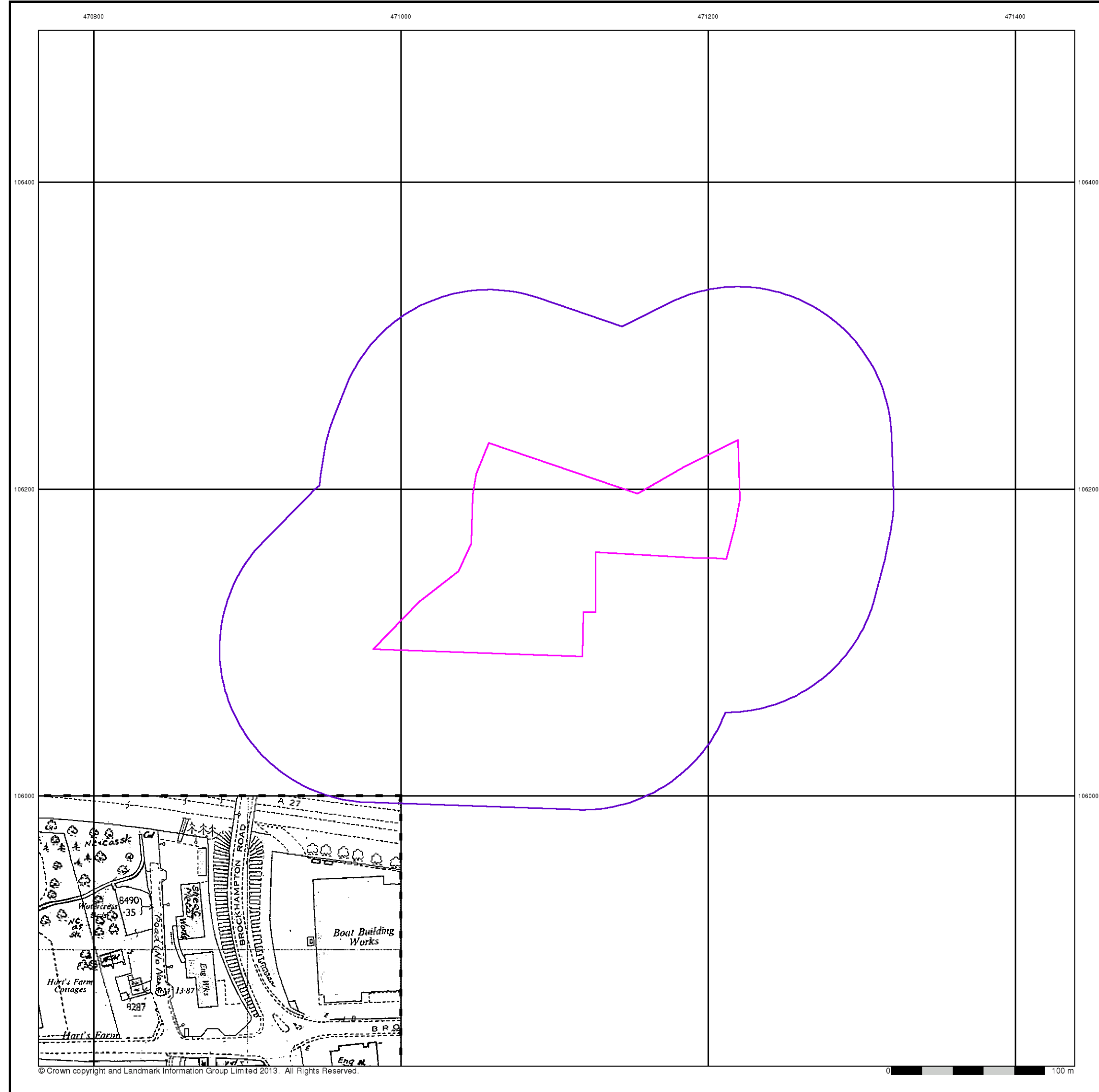
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Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

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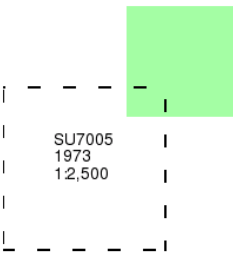
Supply of Unpublished Survey Information

Published 1973

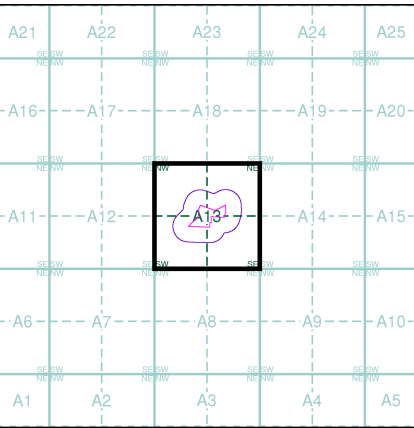
Source map scale - 1:2,500

SUSI maps (Supply of Unpublished Survey Information) were produced between 1972 and 1977, mainly for internal use at Ordnance Survey. These were more of a 'work-in-progress' plan as they showed updates of individual areas on a map. These maps were unpublished, and they do not represent a single moment in time. They were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

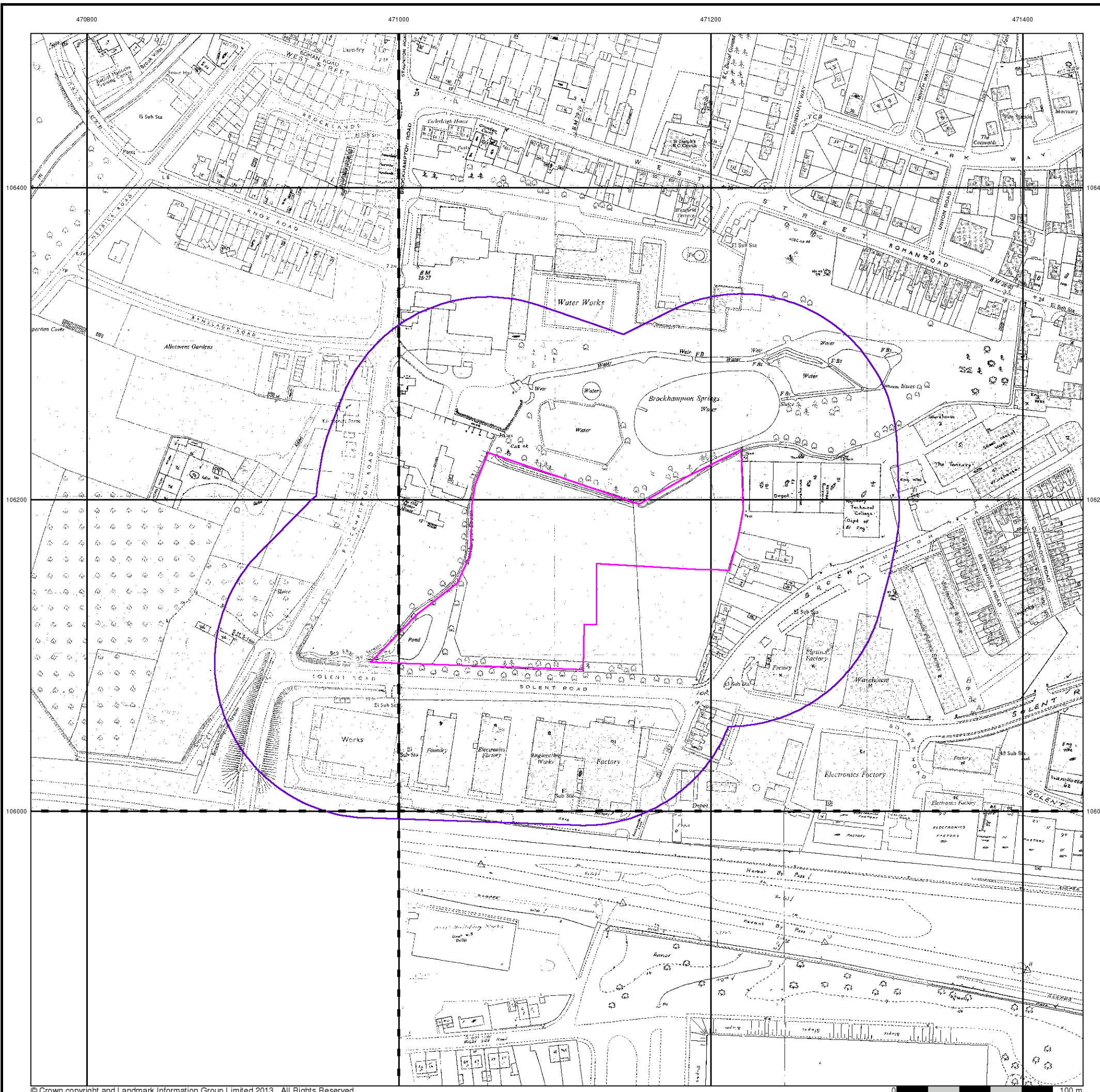
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

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Supply of Unpublished Survey Information

Published 1973

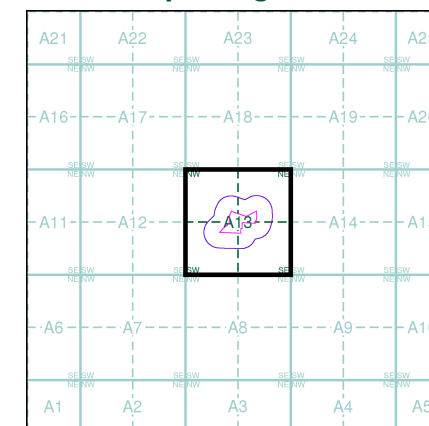
Source map scale - 1:1,250

SUSI maps (Supply of Unpublished Survey Information) were produced between 1972 and 1977, mainly for internal use at Ordnance Survey. These were more of a 'work-in-progress' plan as they showed updates of individual areas on a map. These maps were unpublished, and they do not represent a single moment in time. They were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SU7006SE 1973 1:1,250	SU7106SW 1973 1:1,250
SU7105NW 1973 1:1,250	

Historical Map - Segment A13



Order Details

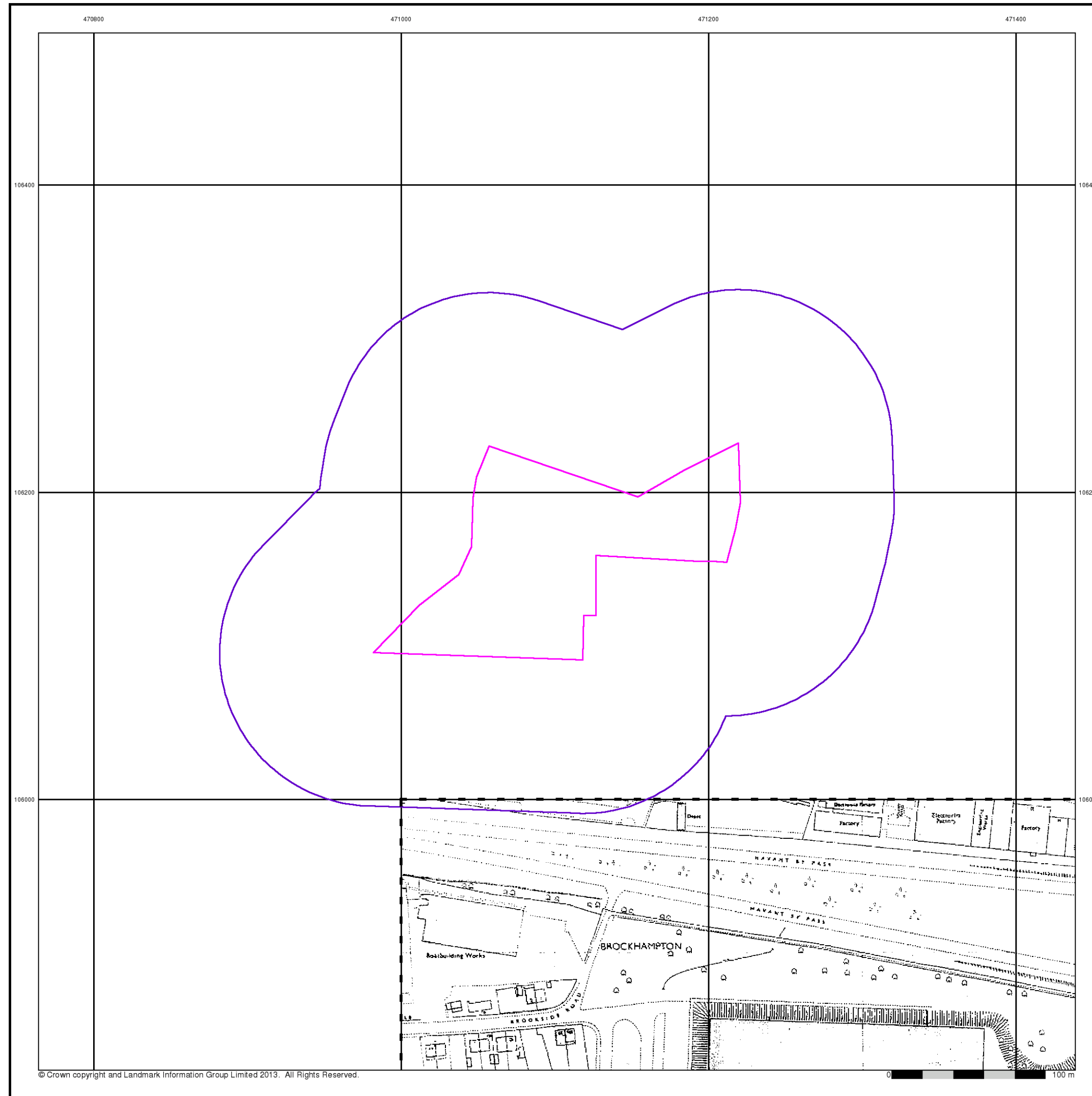
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
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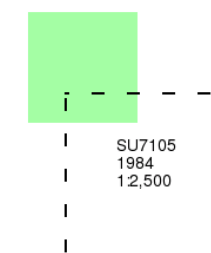
Additional SIMs

Published 1984

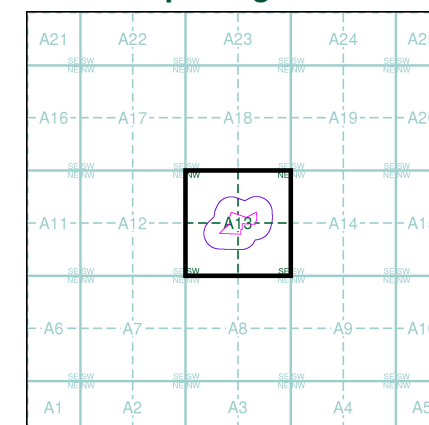
Source map scale - 1:2,500

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

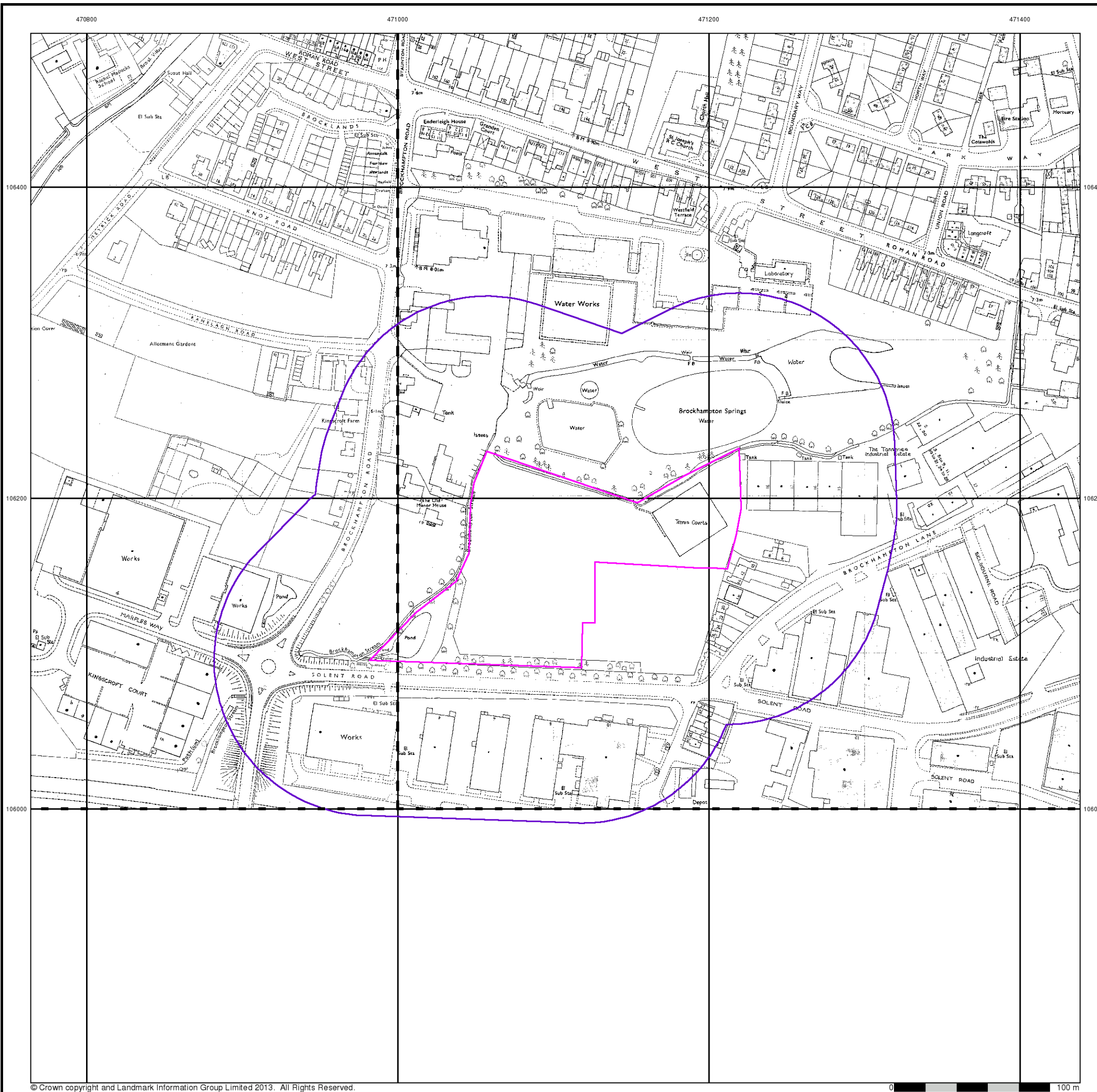
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Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

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Additional SIMs

Published 1987 - 1989

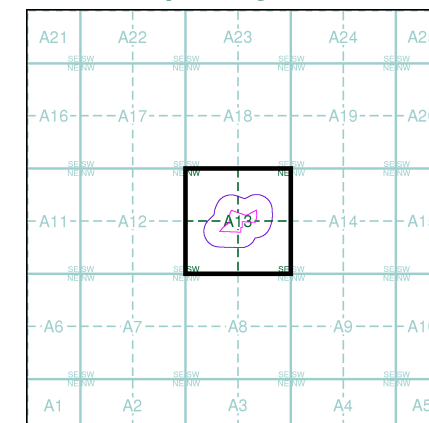
Source map scale - 1:1,250

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)

SU7006SE 1987 1:1,250	SU7106SW 1989 1:1,250
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Historical Map - Segment A13

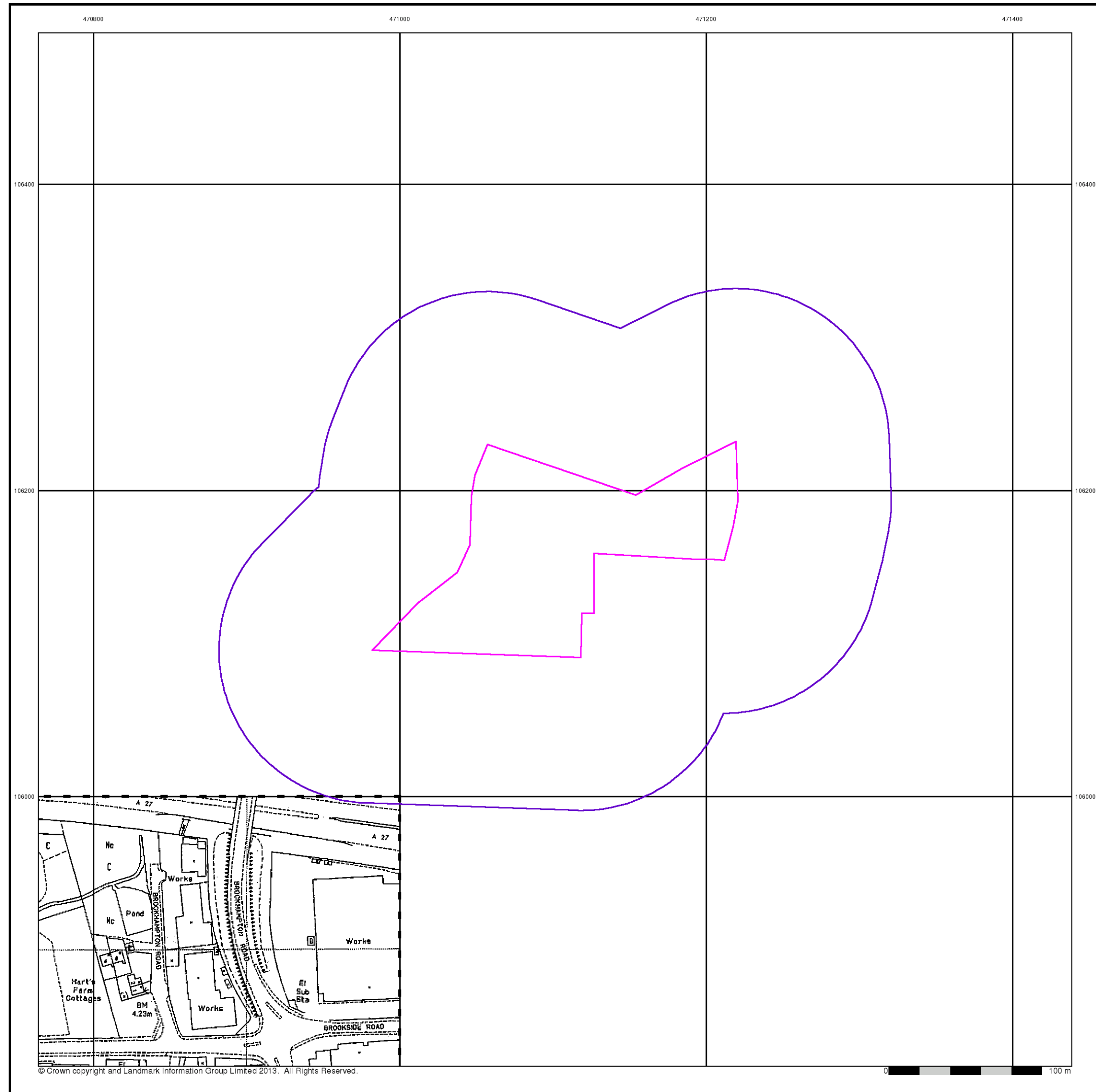


Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
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Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

Land north of, Solent Road, HAVANT, Hampshire, PO9 1DQ



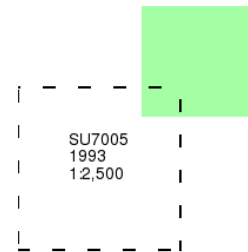
Large-Scale National Grid Data

Published 1993

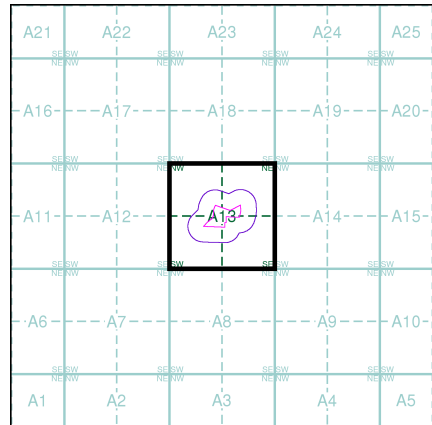
Source map scale - 1:2,500

'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

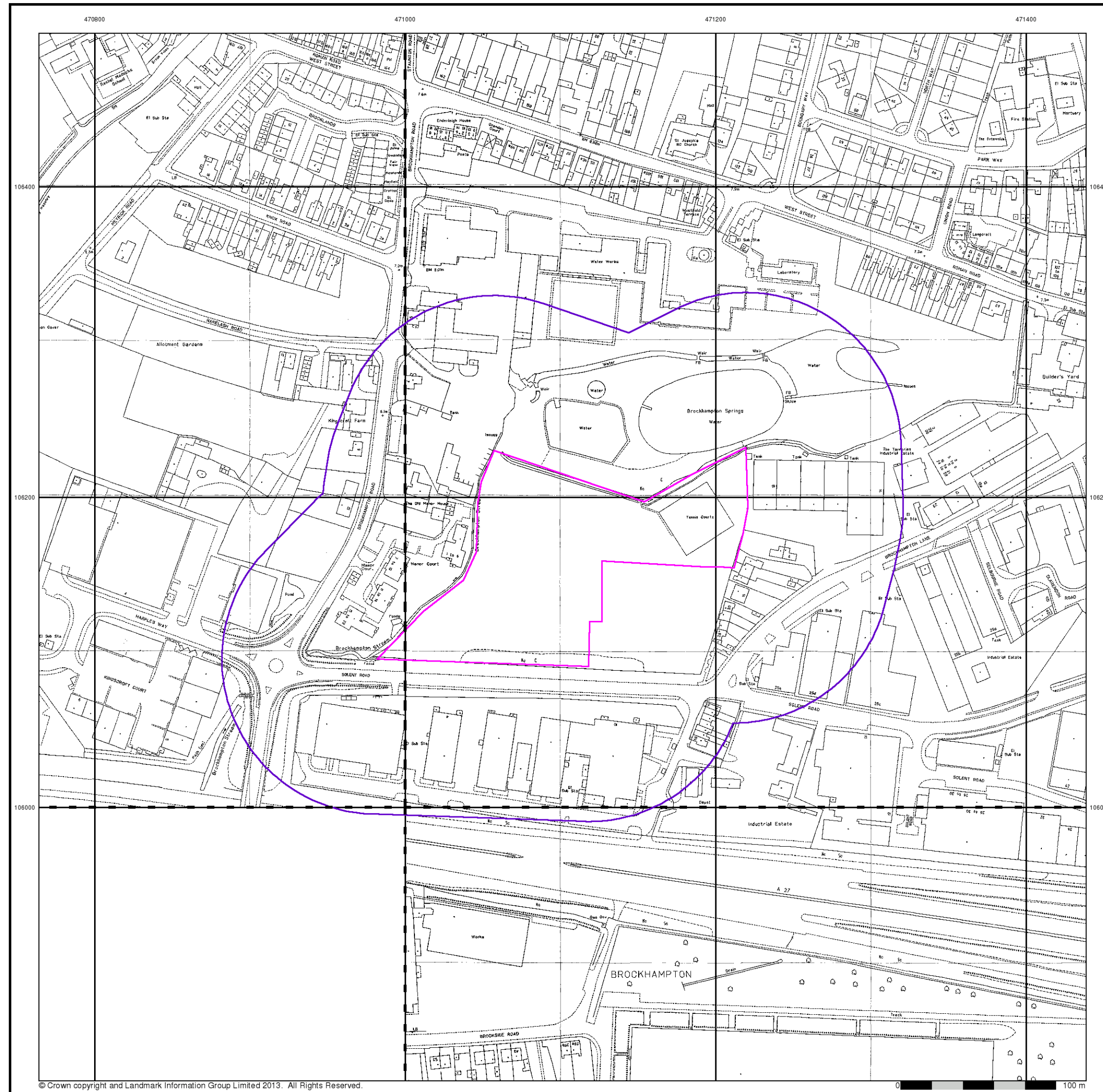
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 100

Site Details

Land north of, Solent Road, HAVANT, Hampshire, PO9 1DQ



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Large-Scale National Grid Data

Published 1993

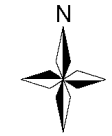
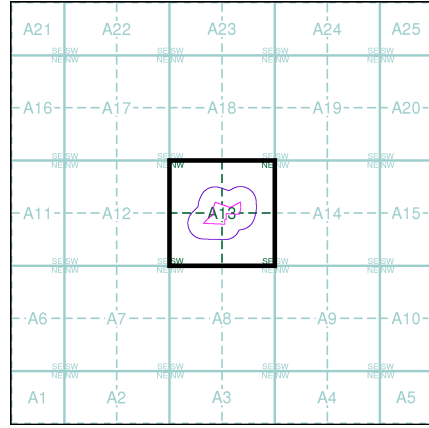
Source map scale - 1:1,250

'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)

SU7008SE	SU7106SW
1993	1993
1:1,250	1:1,250
	SU7105NW
	1993
	1:1,250

Historical Map - Segment A13



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
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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 Boundary Post or Stone		Police Station
	Church		Post Office
	Club House		Public Convenience
	Fire Engine Station		Public House
	Foot Bridge		Signal Box
	Fountain		Spring
	Guide Post		Telephone Call Box
	Mile Post		Telephone Call Post
	Mile Stone		Well

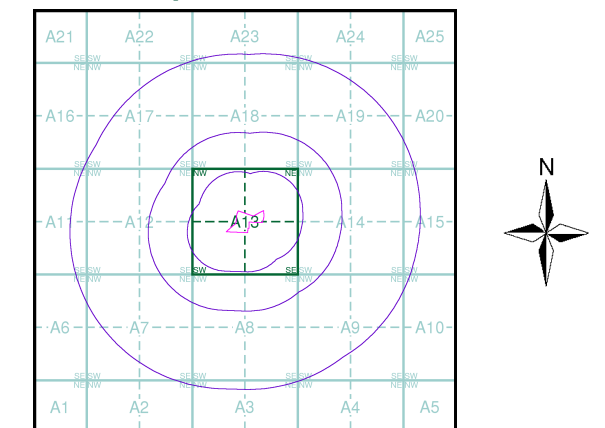
1:10,000 Raster Mapping

	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

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Hampshire & Isle Of Wight	1:10,560	1870	3
Sussex	1:10,560	1879 - 1880	4
Hampshire & Isle Of Wight	1:10,560	1898	5
Sussex	1:10,560	1899	6
Hampshire & Isle Of Wight	1:10,560	1909 - 1910	7
Sussex	1:10,560	1914	8
Sussex	1:10,560	1914	9
Sussex	1:10,560	1914	10
Hampshire & Isle Of Wight	1:10,560	1932	11
Sussex	1:10,560	1932	12
Sussex	1:10,560	1932	13
Hampshire & Isle Of Wight	1:10,560	1932	14
Sussex	1:10,560	1932	15
Hampshire & Isle Of Wight	1:10,560	1933	16
Hampshire & Isle Of Wight	1:10,560	1933	17
Hampshire & Isle Of Wight	1:10,560	1938 - 1942	18
Ordnance Survey Plan	1:10,000	1962 - 1963	19
Ordnance Survey Plan	1:10,000	1966	20
Ordnance Survey Plan	1:10,000	1972 - 1975	21
Ordnance Survey Plan	1:10,000	1982	22
Havant	1:25,000	1983	23
Portsmouth	1:10,000	1988	24
Ordnance Survey Plan	1:10,000	1990 - 1992	25
VectorMap Local	1:10,000	2014	26

Historical Map - Slice A



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 1000

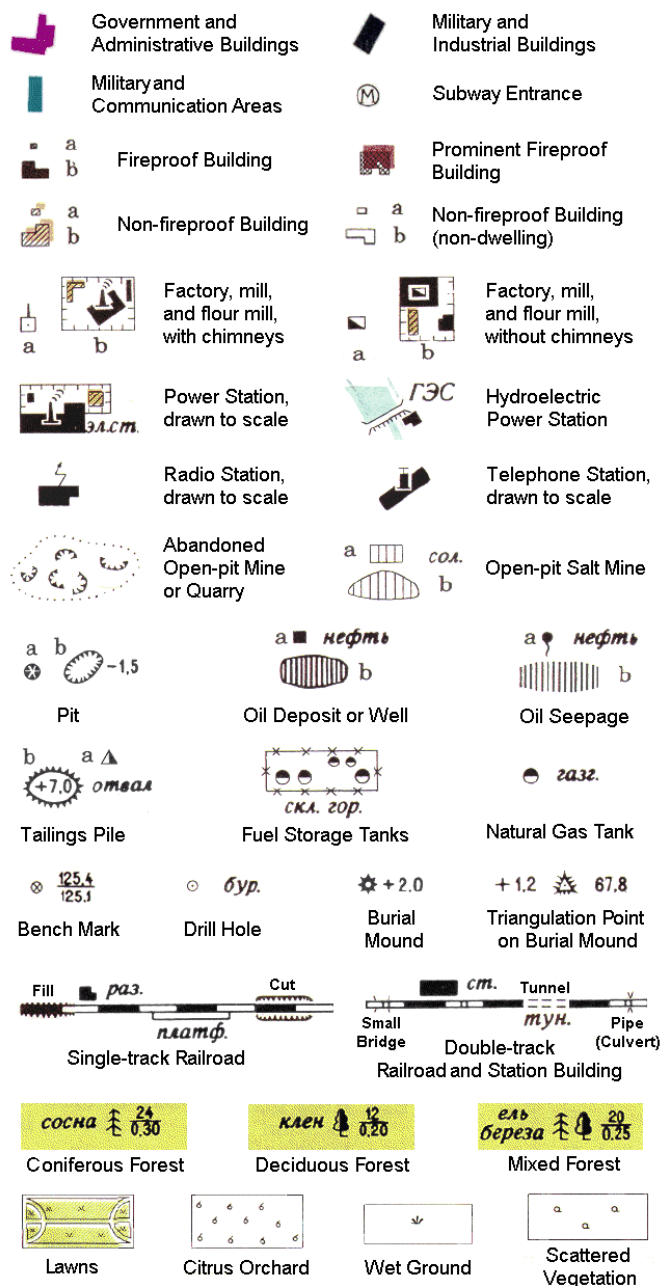
Site Details

Land north of, Solent Road, HAVANT, Hampshire, PO9 1DQ

Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale



243.8 Values for prominent elevations

186.0 Numbers for spot elevations, depth soundings, contour lines, etc.

0.2 Velocity of the current, width of river bed, depth of river

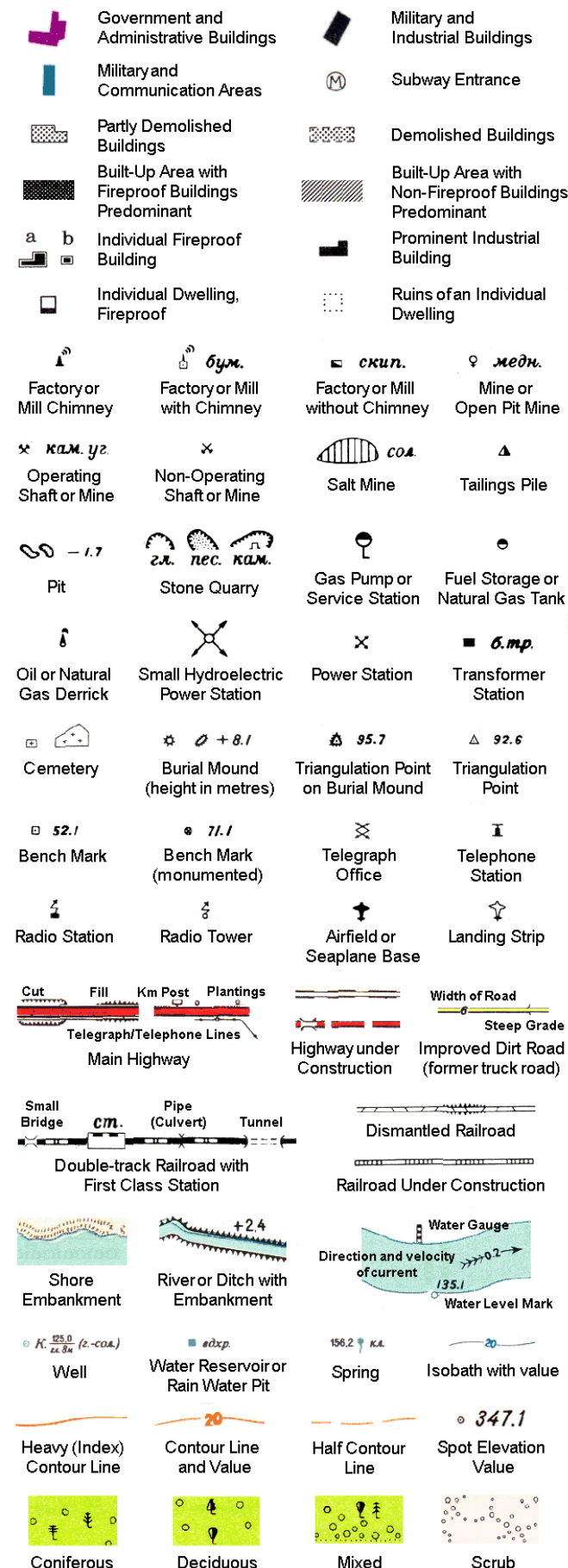
180/12 Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A)	З з (Z)	П п (P)	Ч ч (CH)
Б б (B)	И и (I)	Р р (R)	Ш ш (SH)
В в (V)	Й й (Y)	С с (S)	Щ щ (SHCH)
Г г (G)	К к (K)	Т т (T)	Ъ (-)
Д д (D)	Л л (L)	У у (U)	Ы (Y)
Е е (E)	М м (M)	Ф ф (F)	Ь (')
Ё ё (YO)	Н н (N)	Х х (KH)	Э э (E)
Ж ж (ZH)	О о (O)	Ц ц (TS)	Ю ю (YU or IU)
			Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale



Key to Numbers on Mapping

SU70_Havant

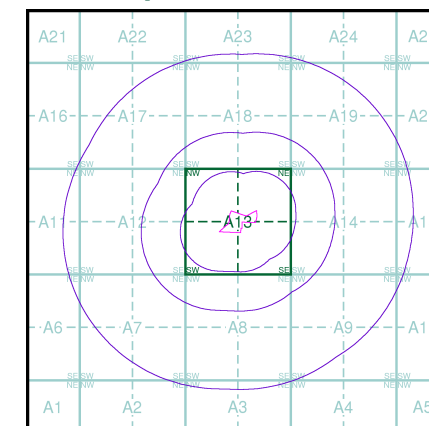
No.	Description
7	Factory (Chemicals)
10	Post Office
15	Railway Station (Freight And Passenger)
16	Sewage Works
17	Sewage Works



Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Hampshire & Isle Of Wight	1:10,560	1870	3
Sussex	1:10,560	1879 - 1880	4
Hampshire & Isle Of Wight	1:10,560	1898	5
Sussex	1:10,560	1899	6
Hampshire & Isle Of Wight	1:10,560	1909 - 1910	7
Sussex	1:10,560	1914	8
Sussex	1:10,560	1914	9
Sussex	1:10,560	1914	10
Hampshire & Isle Of Wight	1:10,560	1932	11
Sussex	1:10,560	1932	12
Sussex	1:10,560	1932	13
Hampshire & Isle Of Wight	1:10,560	1932	14
Sussex	1:10,560	1932	15
Hampshire & Isle Of Wight	1:10,560	1933	16
Hampshire & Isle Of Wight	1:10,560	1933	17
Hampshire & Isle Of Wight	1:10,560	1938 - 1942	18
Ordnance Survey Plan	1:10,000	1962 - 1963	19
Ordnance Survey Plan	1:10,000	1966	20
Ordnance Survey Plan	1:10,000	1972 - 1975	21
Ordnance Survey Plan	1:10,000	1982	22
Havant	1:25,000	1983	23
Portsmouth	1:10,000	1988	24
Ordnance Survey Plan	1:10,000	1990 - 1992	25
VectorMap Local	1:10,000	2014	26

Russian Map - Slice A



Order Details

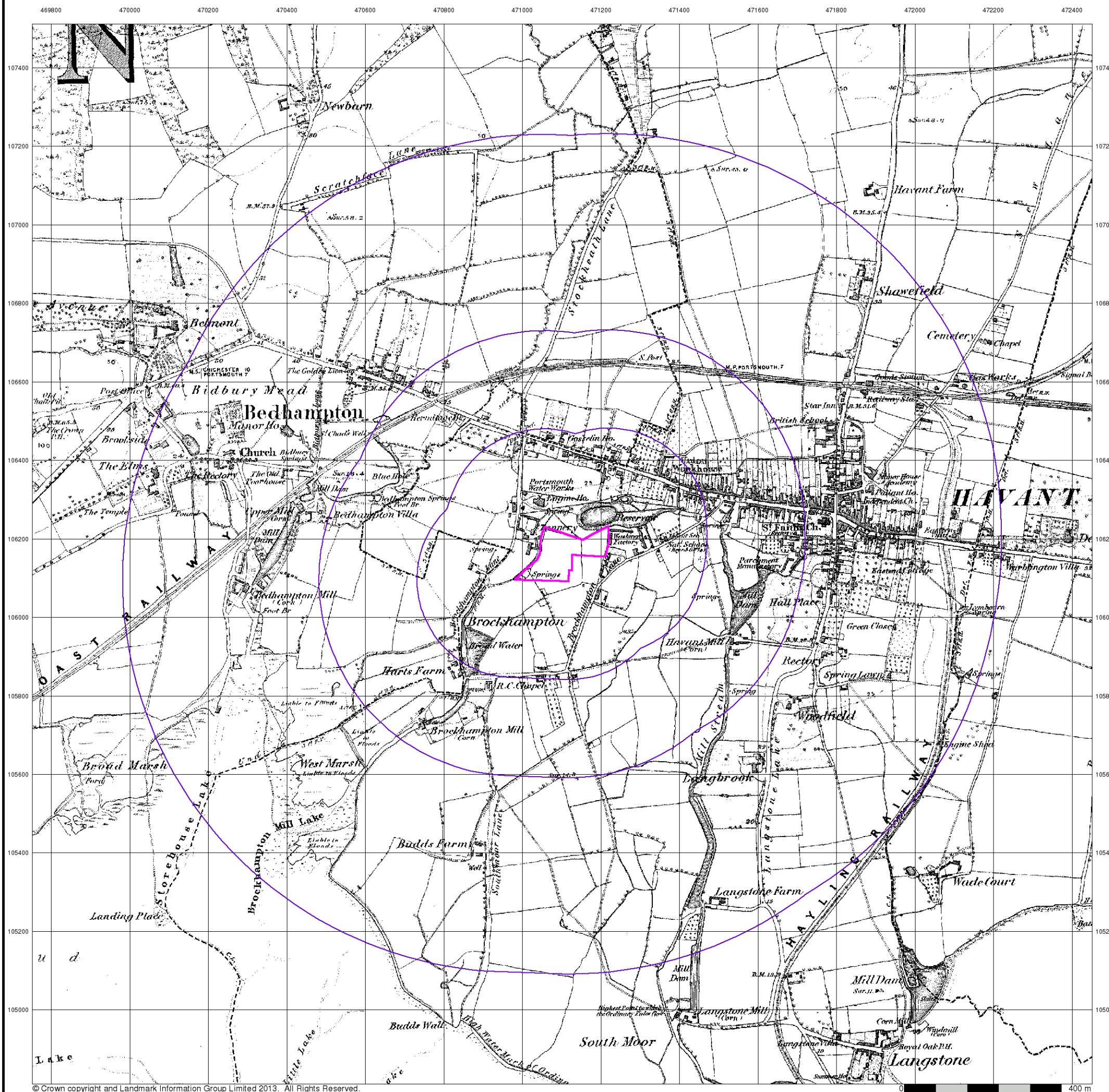
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
Search Buffer (m): 1000

Site Details

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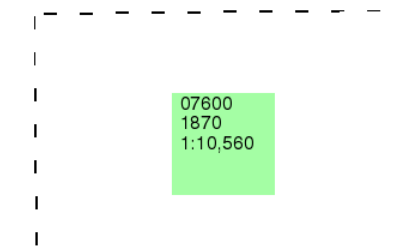
Hampshire & Isle Of Wight

Published 1870

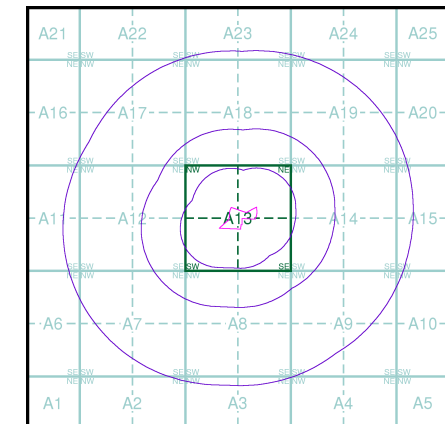
Source map scale - 1:10,560

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



Order Details

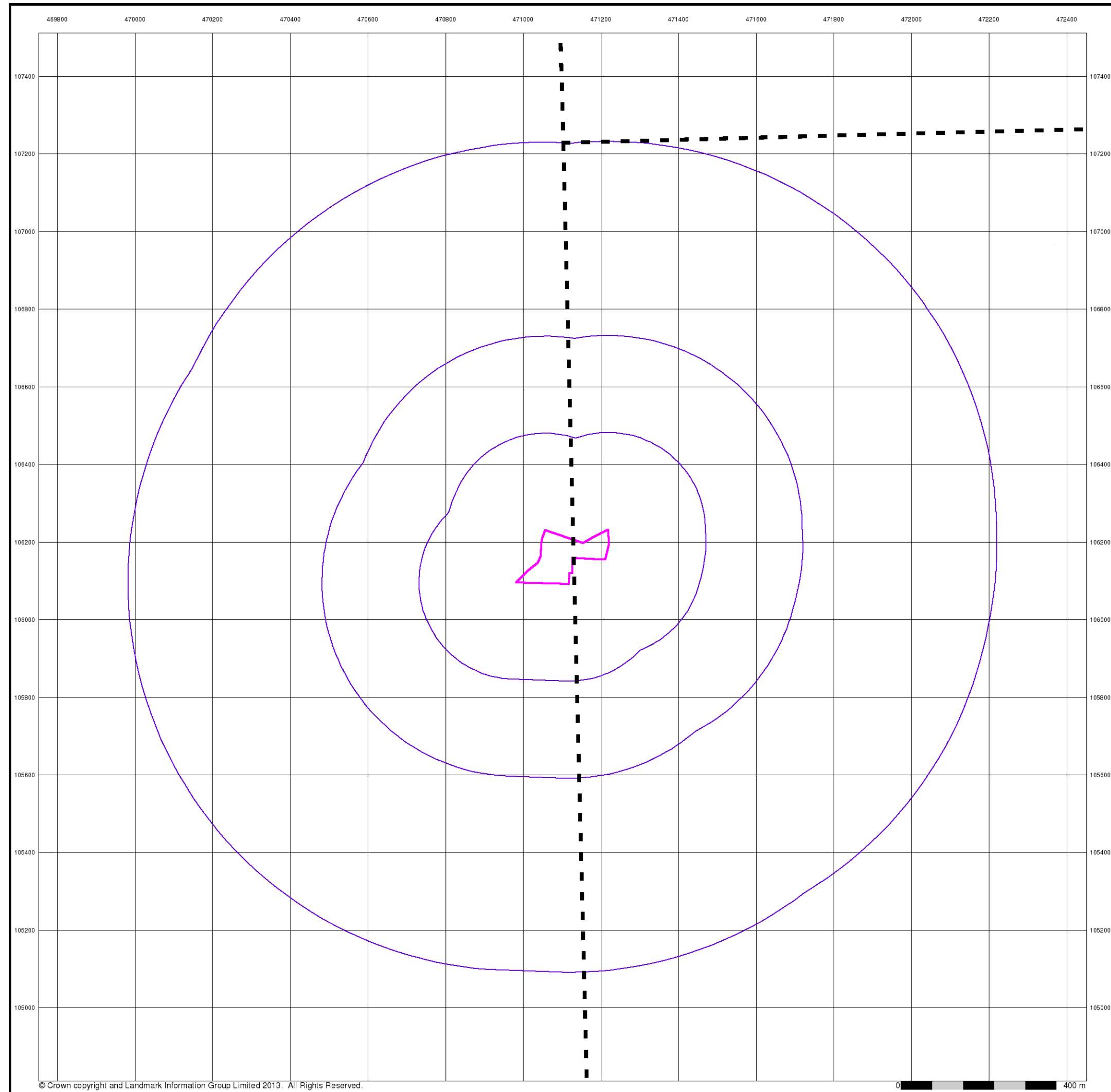
Order Number: 56545315_1_1
Customer Ref: 14252
National Grid Reference: 471100, 106160
Slice: A
Site Area (Ha): 1.7
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Sussex

Published 1879 - 1880

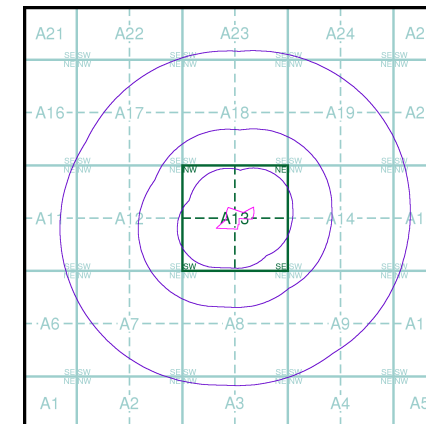
Source map scale - 1:10,560

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)

	04700 1880 1:10,560
	06000 1879 1:10,560

Historical Map - Slice A



Order Details

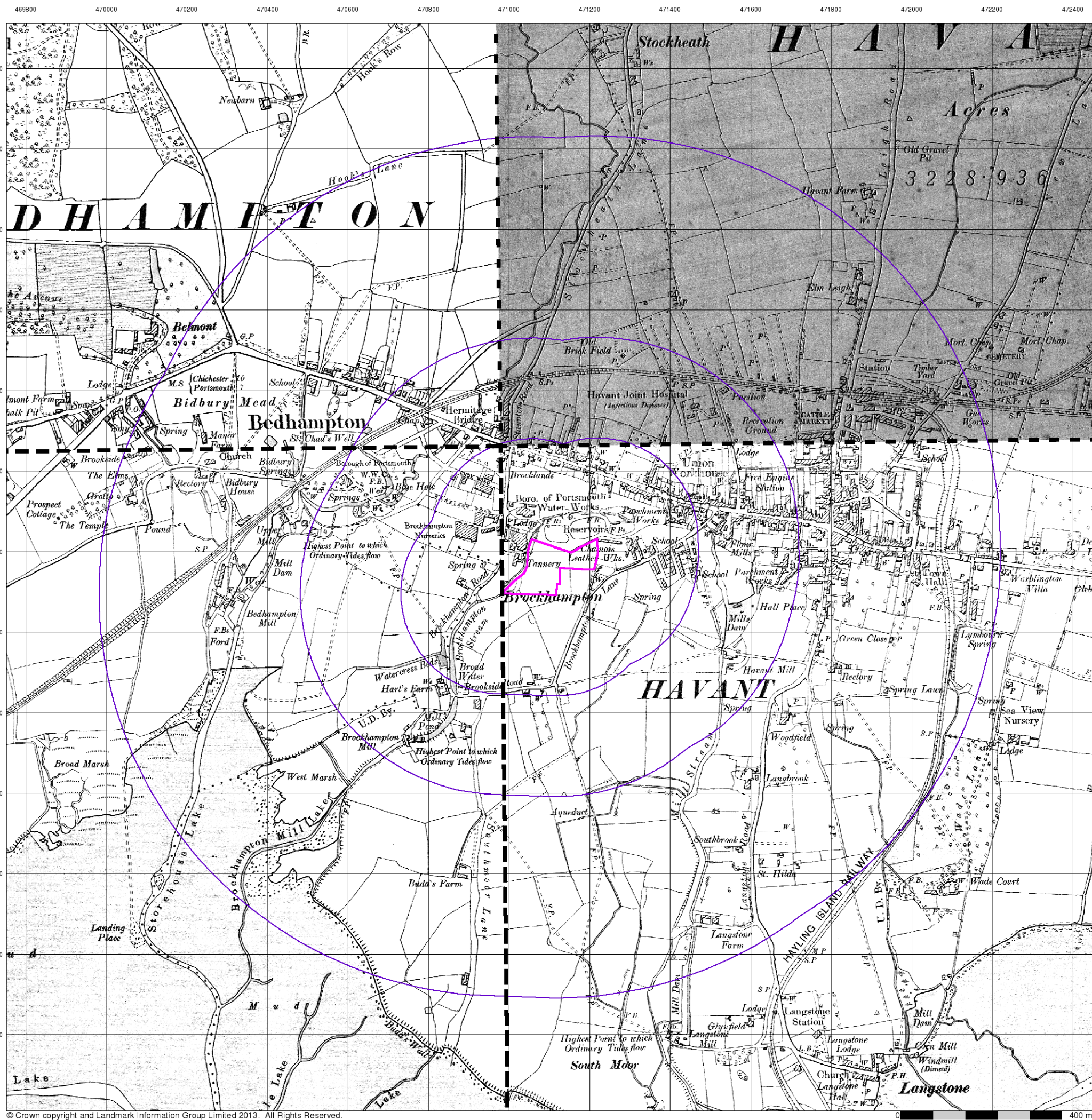
Order Number: 56545315_1_1
Customer Ref: 14252
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Hampshire & Isle Of Wight

Published 1898

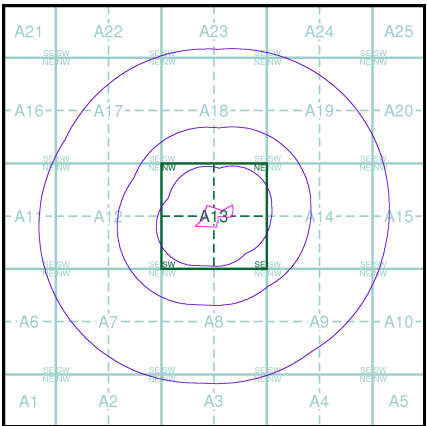
Source map scale - 1:10,560

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)

076NW 1898 1:10,560	076NE 1898 1:10,560
076SW 1898 1:10,560	076SE 1898 1:10,560

Historical Map - Slice A



Order Details

Order Number: 56545315_1_1
Customer Ref: 14252
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Information Group

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