DESK STUDY REPORT
for the land at
MEDWAY BRIDGE MARINA
MANOR LANE,
ROCHESTER, KENT,
on behalf of
KENT PLANNING LTD

GE9823\DSR\APR14 STATUS: FINAL	
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1.0 INTRODUCTION

1.1 General

Geo-Environmental Services Limited was instructed by Kent Planning to undertake a Desk Study of the geotechnical and geo-environmental factors pertaining to land at Medway Bridge Marina, Rochester, Kent ('the site'). The site's location is presented in Figure 1 and an aerial photograph of the site is presented in Figure 3.

1.2 Form of Development

It was understood that the proposed development comprised the construction of single-storey buildings in the vehicle preparation and sales area in the eastern portion of the site as well as a series of garages in the central portion of the site. All of the proposed buildings were present on site during the site walkover. The location of the redeveloped areas is presented in Figure 2.

1.3 Objectives

This desk study has been commissioned to form the Phase I geotechnical and geo-environmental assessment of the site for which potential pollutant linkages and other ground related constraints to development can be determined and where necessary further works recommended.

1.4 Standards and Reference Documents

Where practicable, the desk study was undertaken in accordance with the following documents and guidance:

- National Planning Policy Framework – March 2012.
- Planning Policy Statement 23 Planning and Pollution Control.
- Model Procedures for the Management of Contaminated Land, CLR11, DEFRA and Environment Agency 2004.
- Environment Agency Guidance on Requirements for Land Contamination Reports, Version 1 dated July 2005.
- BS10175:2011 - Investigation of Potentially Contaminated Sites - Code of Practice, BSI 2011.
- BS5930: 1999 - Code of Practice for Site Investigations, BSI 1999.
- BS1377: 1990 – Soils for Civil Engineering Purposes, BSI1990.
- NHBC Standards Chapter 4.1 Land Quality - Managing Ground Conditions, September 1999.
- CIRIA C665 - Assessing risks posed by hazardous ground gases to buildings, revised (2007)
- NHBC 10627-R01(04) - Guidance on evaluation of development proposals on sites where methane and carbon dioxide are present (2007)
- BS8485:2007 Code of practice for the characterisation and remediation from ground gas in affected developments.

1.5 Conditions

The data collected from the desk study has been used to provide a preliminary assessment of the geo-environmental conditions pertaining to the site. The recommendations and opinions expressed in this report are based on the data obtained.

Geo-Environmental Services Limited takes no responsibility for conditions that either have not been revealed in the available records. Whilst every effort has been made to interpret the conditions, such information is only indicative and liability cannot be accepted for its accuracy.

Information contained in the report is intended for the use of the Client, and Geo-Environmental Services Limited can take no responsibility for the use of this information by any third party for uses other than that described in this report.

Geo-Environmental Services Limited does not indemnify any third parties against any dispute or claim arising from any finding or result of this investigation or any claim or dispute arising as a result of any decisions made thereof.

2.0 DESK STUDY

The findings of the Phase I Desk Study are presented in the following section. A copy of the historical maps and background information obtained as part of the desk study is presented in Appendix A.

Comments made in the following sections regarding possible ground conditions on the site are based purely on the desk study. Confirmation of ground conditions can only be provided through undertaking site specific intrusive investigation.

2.1 Site Description

The site comprised an irregular shaped plot of land on the southern bank of the River Medway, Kent, situated within Medway Bridge Marina. The site was noted to slope gently from south to north with approximately 2m height difference between the raised area in the southern portion of the site and the bank of the River Medway. The majority of the site area served as a car park/boat depot associated with the marina and its businesses. Several buildings were located along the south-eastern boundary of the site. These mostly acted as a base for boat building/repair businesses.

A number of jetties associated with the marina were located in the northern-western portion of the site. At the time of a walkover numerous boats were moored along the bank of the river and several more were stored in the depot area.

The surrounding area comprised a mixture of residential dwellings to the south, marshland to the east and River Medway to the north of the site boundary. The M2 motorway ran along the Medway Bridge, located approximately 400m east of the site.

CAR PREPARATION BUILDING

The one storey concrete brick building was located directly north-east of the marina office. At the time of a walkover vehicles were tended to in the forecourt area of the building. A concrete driveway where the cars were being prepared for sales was noted to slope gently towards the main car park. A drain was located at the bottom of the driveway and was presumably connected to the Marina's sewage treatment plant.

CAR SALES AREA

The area comprised a roughly U-shaped area of car park, adjacent to the marina office building. The area was mostly tarmacadam covered with the exception of a small vegetated section separating the car park from the access route to the site. In the centre of the soft landscaping area, a large gas tank was noted containing propane. The gas was supplied to the marina office building via an underground pipe with an entry point to the building visible on its western wall. The tank was separated from the car park area by a tall hedgerow. An electricity cabinet and a manhole were located on the other side of the hedgerow, hidden behind the vehicles parked in the area.

At the time of the walkover survey several vehicles were noted in the car park.

GARAGES

The garages were located in the central portion of the site near a boat servicing area and comprised a single-storey breeze block building housing five individual garages and an adjacent concrete driveway. Disused boat parts and a pile of rubble were noted to be stored along the southern wall of the building.

At the time of the walkover, three of the garages were open and appeared to serve as domestic storage/workshop. Several vehicles were parked in front and along the northern wall of the building.

2.2 Geology

British Geological Survey geological mapping indicated the geology of the site to comprise clay, silt, sand and gravel of the Head Deposits in the southern portion of the site and clay, silt and sand of the Alluvium to the north all overlying the Lewes Nodular Chalk Formation of the Upper Chalk. Given the former development of the site, Made Ground is expected to be present in certain parts of the site.

The term fill or **Made Ground** is used to describe material which has been placed by man either for a particular purpose e.g. to form an embankment, or to dispose of unwanted material. For the former use, the Fill and/or Made Ground may well have been selected for the purpose and placed and compacted in a controlled manner. With the latter, great variations in material type, thickness and degree of compaction invariably occur and there can be deleterious or harmful matter, as well as potentially methanogenic organic material. The BSI Code of Practice for Foundations, BS8004:1986 Clause 2.2.2.3.5 Made Ground and Fill, includes the caveat that “all made ground should be treated as suspect, because of the likelihood of extreme variability”.

Head Deposits are drifts produced by solifluxion, the downslope movement of debris outwash during the periglacial period, and characteristically comprise poorly sorted sands gravels and chalk of local derivation

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.

Upper Chalk is a soft white friable microporous limestone composed of coccolith biomicrites with varying proportion of larger shell fragments. Flint characterises the Upper Chalk, occurring as nodular courses, tabular beds and linings to fractures.

At various levels clay sized material occurs as marl seams and partings. Close to the surface the upper few metres are invariably discoloured brown, due to leaching from the overlying strata. The interface with any overlying stratum is invariably

extremely irregular as a result of localised weathering and general solution. Weathering by frost action may extend to a depth of several metres.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk, sometimes manifesting themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

Within the Chalk Group on the south coast of England the traditional three-fold division into Lower, Middle and Upper Chalk is impractical for mapping purposes and only two divisions are mapped, these being the Lower Chalk and the undivided Middle & Upper Chalk.

2.3 Hydrogeology

The former NRA Groundwater Vulnerability Maps have been superseded with new aquifer designations replacing the older system of classifying aquifers as Major, Minor and Non-Aquifer. This new system is in line with Groundwater Protection Policy (GP3) and the Water Framework Directive (WFD). New designations equate to Principal Aquifers, Secondary Aquifer A, B and Undifferentiated, and finally a third designation of Unproductive Strata.

With reference to the Environment Agency website, the site was recorded as being underlain by superficial deposits classed as a Secondary A aquifer, overlying a Principal Aquifer presumed to relate to the Upper Chalk Formation.

Secondary A Aquifers are regarded as capable of supporting water supplies at local scale and can form important source of base flow to the rivers. Principal Aquifers are highly permeable formations usually with a known or probable presence of significant fracturing. Major Aquifers may be highly productive in terms of water supply, and may be able to support large abstractions for public supply and other purposes.

According to information provided on the Environment Agency website the site falls within groundwater Source Protection Zone (SPZ): SPZ Zone III (Total catchment).
An SPZ is a protection zone placed around a well or borehole that supplies groundwater of potable quality and an SPZ is divided into three zones defined as follows:

- Zone I - the 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50m.
- Zone II - a 400 day travel time from a point below the water table.
- Zone III - the area around a source within which all groundwater recharge is presumed to be discharged at the source.

The site also shown to be located within a High Groundwater Vulnerability Zone, related to being underlain by a Principal Aquifer.

Soils within former mine working or urban areas are assumed to be of high vulnerability until proven otherwise, due to fewer soil classification observations and the potential for historical disturbance. Generally, soils of high leaching potential are defined as having little ability to attenuate diffuse source pollutants and pollutants may therefore move rapidly into underlying strata or shallow groundwater.

No licensed groundwater abstractions were recorded within 1km of the site.

No substantiated pollution incidents or discharge consents to groundwater were identified as part of the desk study within a radius of 250m of the site boundary.

2.4 Hydrology

The nearest surface water feature was River Medway which was located on the site boundary.

The site is indicated to be located within the Environment Agency Zone 3 Flood Zone. A Flood Zone 3 illustrates the Environment Agency's (EA) best estimate of the areas of land that could be affected by flooding, either from rivers or the sea, if there were no flood defences. In Zone 3 the annual probability of flooding from sea is 1% or greater and from rivers 0.5% or greater.

The desk study identified one licensed surface water abstraction within a radius of 1km of the site boundary details of which are provided below:

- Operator: Mr S.T. Scutt; Location: Point A, Common Marsh Lagoon, Near Medway Bridge, Rochester; Abstraction: Construction – Dust Suppression. Distance: 668m west.

The desk study did not identify any recorded pollution incidents to surface water within a radius of 250m of the site boundary.

The desk study also identified five discharge consents to surface water within a radius of 250m of the site boundary, details of which are listed below:

- Final treated effluent discharge from Medway Bridge Marina at Manor Lane, Rochester, Kent, 91m north.
- Discharge of public sewage from storm sewage overflow, Medway Bridge Marina, Manor Lane, Rochester, Kent, 91m north-east.
- Discharge of public sewage from storm sewage overflow, Southern Water Services Ltd, Farmdale Avenue Pumping Station, Rochester Kent, 147m south.
- Discharge of unknown type from Southern Water Services Ltd, Brambletree Crescent, Borstal, Kent, 153m south-west.
- Discharge of public sewage from storm sewage overflow, Southern Water Services Ltd, Bramblebee Crescent, Borstal, Kent, 205m south-west.

2.5 Geochemistry

A large portion of the UK's urban soils have naturally elevated concentrations of some potentially harmful chemicals. In some cases these exceed the Environment Agency CLR soil guideline value (SGV) and/or the Land Quality Management/Chartered Institute of Environmental Health (LQM/CIEH) generic assessment criteria (GAC). A summary of the estimated urban soil chemistry for the area is presented in the following table:

Table 2

Summary of Site Geochemistry

Determinand	Concentration (mg/kg)	In Excess of SGV/GAC*?
Arsenic	15 - 25	No
Cadmium	<1.8	No
Chromium	60 - 90	No
Lead	<150	No
Nickel	15 - 30	No

NOTE: * Comparative SGV concentrations are for a residential end use with plant uptake

It should be noted that these values are not necessarily representative of the site's soil chemistry. Furthermore, SGVs and GACs are dependent on pH and soil organic matter content. Therefore, concentrations of specific determinands and the utilised SGV/GAC cannot be determined without site specific investigation and analysis.

2.5 Sensitive Land Uses

The site was identified as being located outside any sensitive land use areas. However, an Area of Outstanding Natural Beauty (AoONB) and a Local Nature Reserve (LNR) were noted within 500m of the site, details of which are shown below:

- Name: Baty's Marsh, Designation: Local Nature Reserve, Distance: 60m north-east.
- Name: Kent Downs, Designation: Area of Outstanding Natural Beauty, Distance: 379m south-west.

2.7 Environmental Data

Searches of other various environmental databases were made as part of the desk study, including Integrated Pollution Control (IPC) and Integrated Pollution Prevention and Control (IPPC) sites, registered radioactive substances, COMAH sites, explosives sites, Notification of Installations Handling Hazardous Substances (NIHHS) sites, planning permissions for sites involving hazardous substances, contemporary trade directories and fuel station registers.

The following nine potentially contaminative contemporary trade directory entries were identified within a 250m radius of the site boundary:

- Name: Medway Chandlery; Location: Medway Bridge Marina, Manor Lane, Rochester, Kent, ME1 3HS, 44m north-east; Classification: Chandlers; Status: Inactive.
- Name: Inchgreen; Location: Manor Lane, Rochester, Kent, ME1 3HS, 44m north-east; Classification: Boatbuilders & Repairers; Status: Inactive.
- Name: Boat Bits Shop; Location: Manor Lane, Rochester, Kent, ME1 3HS, 44m north-east; Classification: Marine Engineers; Status: Inactive.
- Name: Medway Marine; Location: Manor Lane, Rochester, Kent, ME1 3HS, 44m north-east; Classification: Marine Engineers; Status: Inactive.
- Name: Seaclear Windows Ltd; Location: Manor Lane, Rochester, Kent, ME1 3HS, 98m east; Classification: Boatbuilders & Repairers; Status: Inactive.
- Name: K M S Medway; Location: Manor Lane, Rochester, Kent, ME1 3HS, 110m east; Classification: Marine Engineers; Status: Active.
- Name: Gradewood; Location: 5 Manor Lane, Rochester, Kent, ME1 3HR, 193m south-east; Classification: Timber Preservation Services; Status: Inactive.
- Name: T M Services; Location: 42 Brambletree Crescent, Rochester, Kent, ME1 3LQ, 208m south-west; Classification: Boilers – Servicing, Replacement and Repairs; Status: Inactive.
- Name: Wadhams Plumbing & Heating; Location: 8 Brambletree Crescent, Rochester, Kent, ME1 3LG, 241m south; Classification: Boilers – Servicing, Replacement and Repairs; Status: Active.

No other such sites were identified as part of the desk study within a 250m radius of the site boundary.

2.8 Geotechnical Data

The site lies within an area considered by the Coal Authority as unlikely to be affected by mining activities.

National databases for a number of different geological hazards have been compiled by the BGS, and a summary of the hazard data pertaining to the site itself is presented on the following table:

Table 3

Summary of BGS Geological Hazards

Hazard	Designation
Collapsible ground	No Hazard
Compressible ground	Moderate
Ground dissolution	Very Low
Landslide	Very Low
Running sand	Very Low
Swelling clay	Low

2.6 Radon

Data supplied by the Health Protection Agency and presented within the BRE Radon Guidance Report, 2007 indicates that the site is located in an intermediate probability radon area radon affected area, as between 1 and 3% of homes are above the action level. The report also states that no radon protection measures are necessary in the construction of new dwellings on the subject site.

2.7 Historic Mapping

Historic maps dating back to 1869 were obtained as part of the desk study. A summary of the apparent key features observed on the map extracts both on the site and within the local area is presented within Table 1.

Date	On Site	Off Site
1869	The site comprised open space and formed part of a marshland labelled as 'Borstal Marsh'.	The surrounding area comprised mostly open space. The River Medway was shown directly northeast of the Borstal Marsh, within approximately 100m of the site boundary.
1872-1895	Insufficient map coverage.	Insufficient map coverage.
1895	No significant changes shown.	No significant changes shown.
1896	Several rectangular shaped industrial buildings were located on site, forming part of the 'Borstal Manor Cement Works'. A tramway and associated pier were noted approximately 50m south-west of the works buildings.	A chalk pit and old gravel pit were shown approximately 230m south and 150m southwest of the site boundary. Manor Farm was located c.40m east of the site.
1898	No significant changes shown.	Limited residential development of the area southeast of the site was noted. Borstal Cement Works were located c.500m to the southwest.
1909	An additional tramway was shown to run from a chalk pit towards the works buildings. A travelling crane was located directly north of the works buildings.	The gravel pit noted on a map extract from 1896 was no longer shown indicating that it may have been backfilled.
1909-1910	No significant changes shown.	A previously unlabelled chalk pit was shown approximately 300m southeast of the site.
1931-1933	The site was cleared of the cement works buildings and associated infrastructure.	Significant residential development was shown of the area south and east of the site boundary. The chalk pit located southeast of the site was labelled as 'disused'. Borstal Cement Works were no longer shown on the map extract.
1938	No significant changes shown.	A large recreation ground and allotment gardens were shown c. 50m to the east and c.40m to the southwest respectively. The chalk pit located south of the site boundary was labelled as 'disused'.
1938-1939	No significant changes shown.	No significant changes shown.

Date	On Site	Off Site
1939	No significant changes shown.	No significant changes shown.
1947	(Historical Aerial Photograph) No significant changes shown.	(Historical Aerial Photograph) No significant changes shown.
1953-1960	Insufficient map coverage.	Significant residential development of the area south of the site.
1954-1967	Several industrial buildings were shown within the site boundaries. Medway Yacht Basin was located directly north of the site boundary.	Further residential development of the area. Numerous terraced properties were shown adjacent to the southern boundary of the site.
1960-1965	No significant changes shown.	No significant changes shown.
1960-1989	Insufficient map coverage.	Insufficient map coverage.
1962	No significant changes shown.	No significant changes shown.
1966-1967	Insufficient map coverage.	Insufficient map coverage.
1968	No significant changes shown.	Medway Bridge was shown approximately 200m east of the site boundary.
1966-1967	Insufficient map coverage.	Insufficient map coverage.
1972	Insufficient map coverage.	Insufficient map coverage.
1975	No significant changes shown.	No significant changes shown.
1984	(Russian Map) No significant changes shown.	No significant changes shown.
1984-1987	Limited changes to the layout of buildings located on site.	No significant changes shown.
1989	Insufficient map coverage..	Insufficient map coverage.
1990	No significant changes shown.	No significant changes shown.
1990	No significant changes shown.	No significant changes shown.
1993	No significant changes shown.	Three jetties were shown adjacent to the north-eastern part of the site boundary.
1996	No significant changes shown.	No significant changes shown.
2006	No significant changes shown	Medway Bridge Marina was shown directly north of the site boundary.
2013	No significant changes shown.	No significant changes shown.

Table 1 Summary of Historic Map extracts

According to the available map extracts the site formed part of marshland prior to being developed as cement works in 1986. Industrial buildings and associated infrastructure such as cranes and tramway were cleared before the early 1930s. Between 1954 and 1967 the site was redeveloped with several buildings located in the southern portion of the site. Small changes to the layout of the buildings occurred throughout the mapping period. Recent aerial photography suggests that the majority of the site area is currently being used as car park/depot associated with the marina.

The surrounding area comprised mostly open space with chalk pits, gravel pit and cement works located in vicinity of the site. By the late 1930s the pits were disused and significant residential development of the area took place between 1953 and 1967. In the early 1990s, several jetties were constructed adjacent to the northern boundary of the site and labelled as Medway Bridge Marina.

2.8 Ground Gases

A search of historical and current recorded landfill sites was undertaken on the Environment Agency's website as part of the desk study. Such sites may form an artificial source of ground gases, such as carbon dioxide and methane, where wastes are buried or disposed of to landfill.

According to the Environment Agency data, one BGS recorded landfill currently operates within a radius of 500m of the site area details of which area provided bellows:

- Name: Old Chalk Pit; Location: Borsted, Rochester, Kent, 281m south-east; Type of waste received: Unknown.

Two historical landfill sites were also identified within 500m of the site area, details of which are provided below.

- Name: Borstal; Location: Rochester, Kent, 144m south-east; Type of waste received: Inert.
- Name: Manor Lane; Location: Borstal, Medway, Kent, 280m south-east; Type of waste received: Household.

2.9 Previous Ground Investigations

Geo-Environmental had previously undertaken two ground investigations on the subject site in January and July 2007. A summary of the findings presented in previous reports is included below.

The ground conditions encountered were consistent with the anticipated geology. Beneath a thin mantle of Topsoil and Made Ground the geology comprised Alluvium and possible Head Deposits overlying Upper Chalk. Made Ground was encountered within all borehole locations with varying thickness which was found to generally commensurate with the variation in topographic levels. The average depth of Made Ground was 2.40m across the site.

Underlying the Made Ground, Alluvium was encountered in each of the boreholes and generally comprised soft grey silty clay with occasional flint, chalk and wood fragments and pockets of peat.

Upper Chalk was encountered across the site with significant variations to the depth of the top of the Upper Chalk, reflecting both the changes in the levels of the site and the thickness of Alluvial Deposits. The Upper Chalk was encountered at a maximum depth of 13.20m in BH1 (nearest to river bank), and a minimum of 2.70m in WS5. The Upper Chalk was generally weathered at shallow depth (CIRIA Grade Dm), becoming less weathered and more intact chalk with depth (CIRIA Grade C5-C4).

Groundwater was encountered within the majority of the boreholes during the intrusive investigation at strike depths varying between 1.50m and 12.30m. Changes in groundwater levels do occur for a number of reasons including seasonal effects and variations in drainage. It is highly likely that the groundwater levels are influenced by tidal variations with both lag and attenuation.

Given the presence of deep Made Ground and Alluvium across the site it was considered unlikely that conventional shallow foundations would be suitable for the proposed development. An alternative solution such as piles reinforced with concrete ground beams was suggested.

Shallow excavations within the Made Ground and Alluvium were deemed marginally stable in the short and medium term and the use of support of battering pack to a safe angle was recommended. Deeper excavations within the Made Ground and Alluvium were deemed unlikely to remain stable in the short to medium term and significant spalling and localised collapse is to be anticipated, particularly where groundwater is encountered.

Due to the significant thickness of Made Ground and the relatively shallow groundwater the use of soakaways as an effective method of drainage was not recommended for the subject site.

2.10 Generic Contamination

Based on the information gained from the desk study the site appears to have comprised cement works prior to being developed as the Medway Bridge Marina with associated car park and boat servicing areas. Several workshops were noted to operate on site offering services such as anti-foul removal and vehicle paint spraying which could potentially result in contamination of parts of the site.

Given the industrial development of the site it is possible that Made Ground may be present on site. Potential contaminants associated with the presence of Made Ground include elevated metals, non-metals, sulphate and asbestos and organic contaminants.

The chemical quality of the soil beneath the site may have been impacted by the activities undertaken on the site or by aerial deposition of contaminants such as lead or PAHs from car exhaust fumes and the storing and burning of fossil fuels. Elevated concentrations of contaminants within the Natural Ground are also likely to occur on site including elevated metals, non-metals and organic contaminants.

2.11 Ground Gas Summary

The desk study has identified the presence of potential infilled land – c. 150m southwest and 230m south of the site boundary. Also, the presence of deep Made Ground was identified during previous investigation on site which may act as a potential source of gas on the subject site or within the immediate surrounding area; as such it is considered that the potential risk of ground gases on the site as a results of current and historical land uses is moderate.

CIRIA C665 prescribes minimum monitoring periods, as summarised within Table 2:

Example of generation potential		Generation potential of source [1,2]				
		Very Low	Low	Moderate	High	Very High
		Inert Made Ground	Alluvium or dock silt	Pre-1960 landfill	Shallow mine workings	Post 1960's domestic landfill
Sensitivity of development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12 [3]	24/24 [3]

Table 2 Summary of likely gas monitoring requirements

Notes:
1 – First number is the minimum number of readings and the second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.
2 – At Least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions.
3 – The frequency and period states are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required. The NHBC guidance is also recommending these periods/frequency of monitoring.
4 – Historical data can be used as part of a data set.
5 – Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.
6 – Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long-term monitoring may not be appropriate or required.

Methane is an asphyxiating flammable and toxic gas with a density about two-thirds that of air. Methane is toxic at concentrations in excess of 30%v/v and flammable at concentrations of between 5% and 15% by volume in air. Such a methane-air mixture will explode where confined in some way and ignited. The 5% by volume concentration is termed the lower explosive limit (LEL).

Carbon dioxide is a non-flammable toxic and asphyxiating gas which is about 1.5 times heavier than air. In addition, the presence of elevated carbon dioxide may be in conjunction with depleted concentrations of oxygen. Carbon dioxide is inflammable and may affect the flammability of methane by correspondingly reducing the concentration of oxygen within an atmosphere.

With reference to Table 2, the proposed development is considered a 'low' sensitivity. Information obtained from the desk study suggests that the current and historical land uses of the site and surrounding area pose little risk in terms of gas generation potential.

3.0 PRELIMINARY RISK ASSESSMENT

Based on the findings of the desk study the following sections summarise the anticipated geotechnical and environmental factors likely to impact the site.

3.1 Preliminary Environmental Conceptual Site Model & Risk Assessment

3.1.1 Methodology

A Preliminary Risk Assessment (PRA) and Conceptual Site Model (CSM) have been prepared in accordance with CLR11 based on information obtained as part of the Desk Study. Possible risks associated with potential sources of contamination and sensitive receptors identified have been qualitatively assessed following a source-pathway-receptor (pollutant linkage) approach in accordance with current UK protocols.

A risk may only exist where a plausible pollutant linkage is present, and where the quantity or concentration of a contaminant is sufficient so as to pose harm. Under the statutory definition, "Contamination" may only strictly exist where contaminants pose a risk of harm to a receptor. Risk may be defined as a function of the likelihood and severity of any adverse effects arising from contamination. The risk classification has been assessed in accordance with CIRIA C552 (Rudland *et al*., 2001). A summary of how the risks are derived and their definitions are presented in Tables 3.1 and 3.2.

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

Table 3.1 Risk Ratings Matrix

Risk Rating	Definitions
Very high risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR, there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability.

	Urgent investigation (if not already undertaken) and remediation are likely to be required.
High risk	Harm is likely to arise to a designated receptor from an identified hazard Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not already undertaken) is required and remediation works may be necessary in the short term and are likely over the longer term.
Moderate risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
Moderate to low risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is unlikely that any such harm would be severe, or if any harm were to occur it is probable that the harm would be relatively mild.
Low risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very low risk	There is low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table 3.2 Risk Rating Definitions

3.1.2 Summary of Plausible Sources

Possible sources of contamination identified or discounted as part of the Desk Study are summarised in Table 3.3.

Source	Description	Contaminants	On/Off Site
Current land uses	Background chemical quality of near surface soils	Possible elevated metals, organic and inorganic contaminants, and pesticides	On
Former on-site Cement Works and off-site infilled gravel and chalk pits.	Migration of artificially generated ground gases and mobile contaminants on to site.	Ground gas: possible elevated methane, carbon dioxide, volatile organic compounds (VOCs); reduced oxygen. Mobile contaminants: Possible elevated metals, organic and inorganic contaminants.	On/Off
Current on site car and boat servicing areas.	Migration of artificially generated ground gases and mobile contaminants on site.	Ground gas: possible elevated methane, carbon dioxide, volatile organic compounds (VOCs); reduced oxygen. Mobile contaminants: Possible elevated metals, organic and inorganic contaminants.	On

Table 3.3 Possible Sources of Contamination

Table 3.4 further summarises the sources of potential contamination prior to the qualitative risk assessment.

Grouped Sources	Individual Sources
Background chemical quality of near surface soils and Made Ground including possible elevated metals, organic and inorganic contaminants, and pesticides	Current industrial land use
Background chemical quality of near surface soils and groundwater	Former on-site cement works.
Ground gases hydrocarbons metals, organic and inorganic contaminants.	Current on-site car and boat servicing areas.

Table 3.4 Grouped Sources of Contamination

3.1.3 Summary of Plausible Pathways

The plausible pathways are summarised in Table 3.5.

Pathway	Description
Direct Contact	Soil, dust and vegetable ingestion, dermal contact and dust inhalation.
Soil Gas Inhalation	Inhalation of soil gas both inside and outside of buildings.
Vertical & Lateral Migration	Contaminant movement both vertically through leaching/gravity and horizontally along preferential pathways or with groundwater.
Root Uptake	Uptake of soil and waterborne contaminants by plants.
Chemical Attack	Attack of buried plastics and concrete by aggressive ground conditions.

Table 3.5 Possible Contamination Pathways

3.1.4 Summary of Plausible receptors

Potential receptors associated with the site and its development, identified or otherwise discounted, are summarised in Table 3.6.

Receptor	Description	Comments	Plausible
End Users	Commercial end users of the proposed redevelopment	The proposed redevelopment includes small areas of soft landscaping	***Yes***
Adjacent Land Users	Sensitive land uses identified within the immediate vicinity	Adjacent land uses are predominantly residential	***Yes***
Soft Landscaping	Areas of planting including lawns, shrubs, trees, etc.	Areas of soft landscaping are proposed as part of the redevelopment	***Yes***
Water Supply Pipes	Plastics for potable water supply pipes may be laid in contact with contaminated soils	Significant depths of Made Ground are expected	***Yes***
Building Materials	Buried concrete for foundations etc. may be laid in contact with contaminated soils	Significant depths of Made Ground are expected	***Yes***
Groundwater	Controlled waters contained within the aquifer(s) beneath the site	The site lies upon a Secondary 'A' aquifer, outside of any SPZ. The underlying Upper Chalk is a Principal Aquifer.	***Yes***

Surface Water	Controlled waters within lakes, rivers, and ponds, etc., or coastal waters	River Medway immediately adjacent to the site	***Yes***
Sensitive Land Uses	Sensitive land uses or designations identified on site or in the vicinity	Local Nature Reserve (LNR) and an Area of Outstanding Natural Beauty (AONB) located within 500m of the site	***Yes***

Table 3.6 Possible Receptors of Contamination

Site workers involved in the preparation and construction of the development have not been considered in this assessment as the Principal Contractor is duty bound under the current CDM Regulations to undertake their own risk assessments with respect to their employees and develop safe systems of work.

Whilst the above sources and receptors have been identified, Table 3.7 summarises the identified plausible pollution linkages and a qualitative assessment of the risks based on the Desk Study research:

Potential Source/ media	Potential Receptors	Potential Pathways	Probability	Consequence	Risk and Justification
On Site near surface soils & Made Ground	End users	Direct contact	Likely	Mild	Moderate to Low Future commercial users are likely to come into contact with soils via direct contact in car park area. The consequence is likely to be mild.
	Adjacent land users	Direct contact	Low	Mild	Low There is a low likelihood of adjacent site users coming into contact with affected soils. The consequence is likely to be mild.
	Soft Landscaping	Root uptake	Likely	Minor	Low Root uptake is likely for plants but the areas of soft landscaping are very limited. The consequence is likely to be minor.
	Water supply pipes	Chemical attack	Likely	Mild	Moderate to Low Water supply pipes are likely to come into contact with soils

Potential Source/ media	Potential Receptors	Potential Pathways	Probability	Consequence	Risk and Justification
					though significant contamination is not anticipated. The consequence is likely to be mild.
	Buildings and infrastructure	Chemical attack	Likely	Minor	Low Foundations and utilities will be placed within Made Ground. However, the consequence is anticipated to be minor.
	Groundwater	Vertical migration	Likely	Medium	Moderate Groundwater is likely to be encountered at varying depths of between 1.5-12mbgl across the site. Deep Made Ground was previously recorded across the site. Several car and boat servicing areas were noted on site as potential sources of potential contamination. The risk of soils impacting the groundwater is considered to be mild.
	Surface Water	Lateral migration	Likely	Medium	Moderate Water courses present on and immediately adjacent to the site. Some localised concentrations of hydrocarbons may be anticipated on site. The consequence is anticipated to be mild.
Ground Gas	End users	Inhalation	Likely	Mild	Moderate to Low Former gravel and chalk pits have been identified off-site and area. These are likely to have been infilled and form a source of ground gases which can migrate to site. The consequence is anticipated to be mild.

Potential Source/ media	Potential Receptors	Potential Pathways	Probability	Consequence	Risk and Justification
	Soft Landscaping	Root uptake	Likely	Minor	Low Root uptake is possible for plants but any consequence is likely to be minor.

Table 3.7 Plausible Pollutant Linkages & Qualitative Risk Assessment

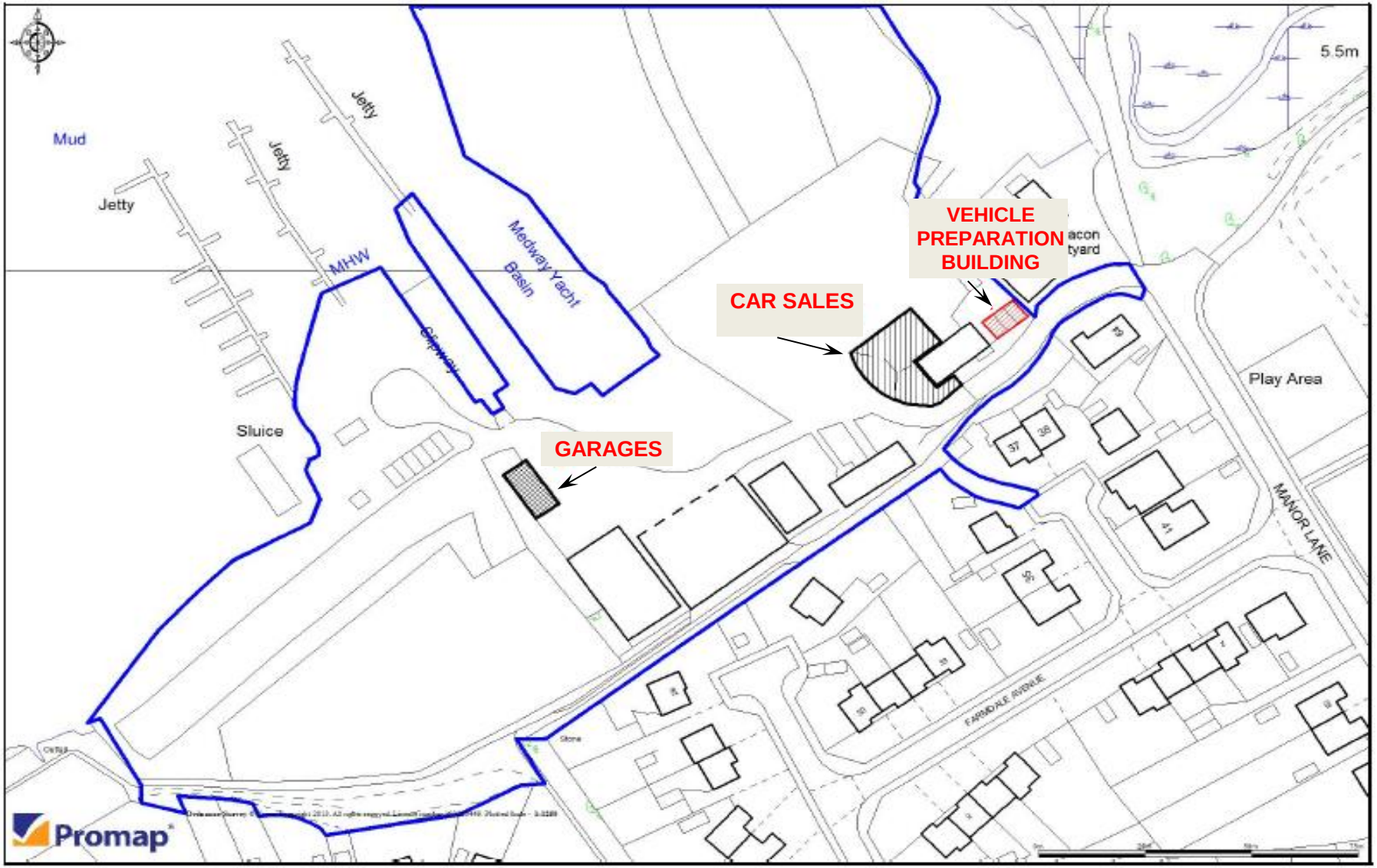
3.2 Preliminary Risk Assessment Summary

The PRA and CSM developed from the information gathered as part of the desk study process has identified several plausible pollutant linkages that exist in relation to the proposed redevelopment of the site. However, the preliminary risk rating for each linkage has been classified as moderate, moderate to low or low, and as such the site is considered overall as moderate to low risk.

FIGURES

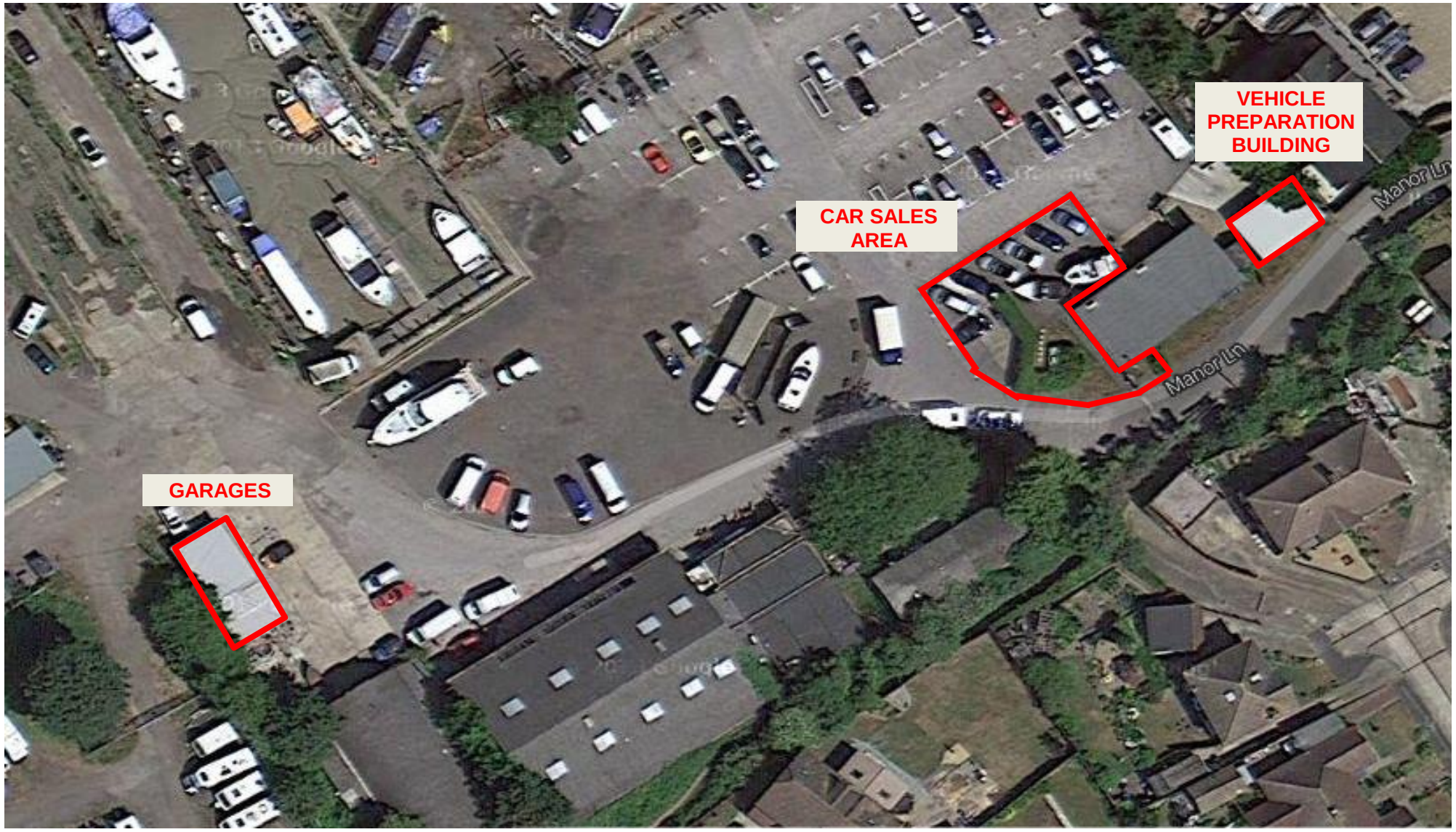
Project:	Medway Bridge Marina III			**Title**	**Site Location Plan**
Client:	Kent Planning Ltd			**Geo-Environmental Services Limited**	
Ref No:	GE9823	**Revision:**	v1	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	JO	**Date:**	11/02/2014	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	1	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

Geo-Environmental



Project:	Medway Bridge Marina III			**Title**	**Site Plan**
Client:	Kent Planning Ltd			**Geo-Environmental Services Limited**	
Ref No:	GE9823	**Revision:**	v1	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	JO	**Date:**	11/02/2014	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	2	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

Geo-Environmental



Project:	Medway Bridge Marina III			**Title**	**Aerial Photograph**
Client:	Kent Planning Ltd			**Geo-Environmental Services Limited**	
Ref No:	GE9823	**Revision:**	v1	**Unit 7, Danworth Farm, Cuckfield Road,**	
Drawn:	JO	**Date:**	11/02/2014	**Hurstpierpoint, West Sussex, BN6 9GL**	
Figure:	3	**Scale:**	Not To Scale	**E: mail@gesl.net T: 01273 832972**	

Geo-Environmental

APPENDIX A

Historical Maps

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
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
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
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)
R.D. Bdy. 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
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Electricity Transmission Line
Sloping Masonry
Pylon
Pole
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
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
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

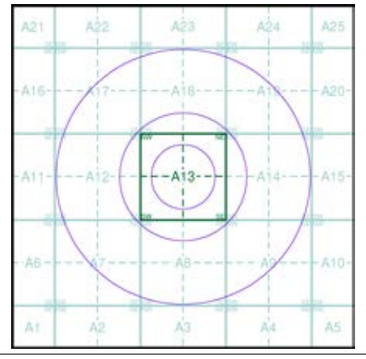
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community 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
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m 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

Envirocheck®

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Kent	1:10,560	1869	3
Kent	1:10,560	1898	4
Kent	1:10,560	1909 - 1910	5
Kent	1:10,560	1931 - 1933	6
Kent	1:10,560	1938	7
Kent	1:10,560	1938 - 1939	8
Kent	1:10,560	1939	9
Historical Aerial Photography	1:10,560	1947	10
Ordnance Survey Plan	1:10,000	1962	11
Ordnance Survey Plan	1:10,000	1968	12
Ordnance Survey Plan	1:10,000	1975	13
Gillingham	1:10,000	1984	14
Ordnance Survey Plan	1:10,000	1990	15
10K Raster Mapping	1:10,000	2006	16
10K Raster Mapping	1:10,000	2013	17

Historical Map - Slice A



Order Details

Order Number: 53195788_1_1
Customer Ref: GE9823
National Grid Reference: 572820, 167040
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

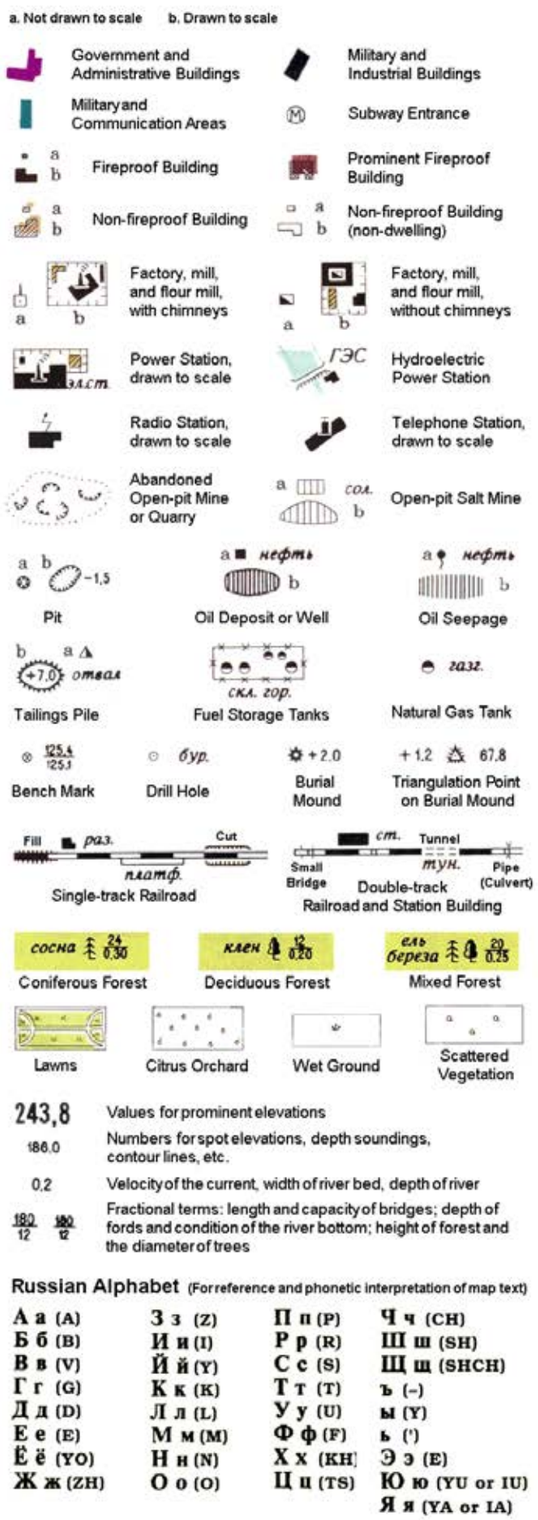
Medway Bridge Maina, Rochester, ME1 3HT

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Russian Military Mapping Legends

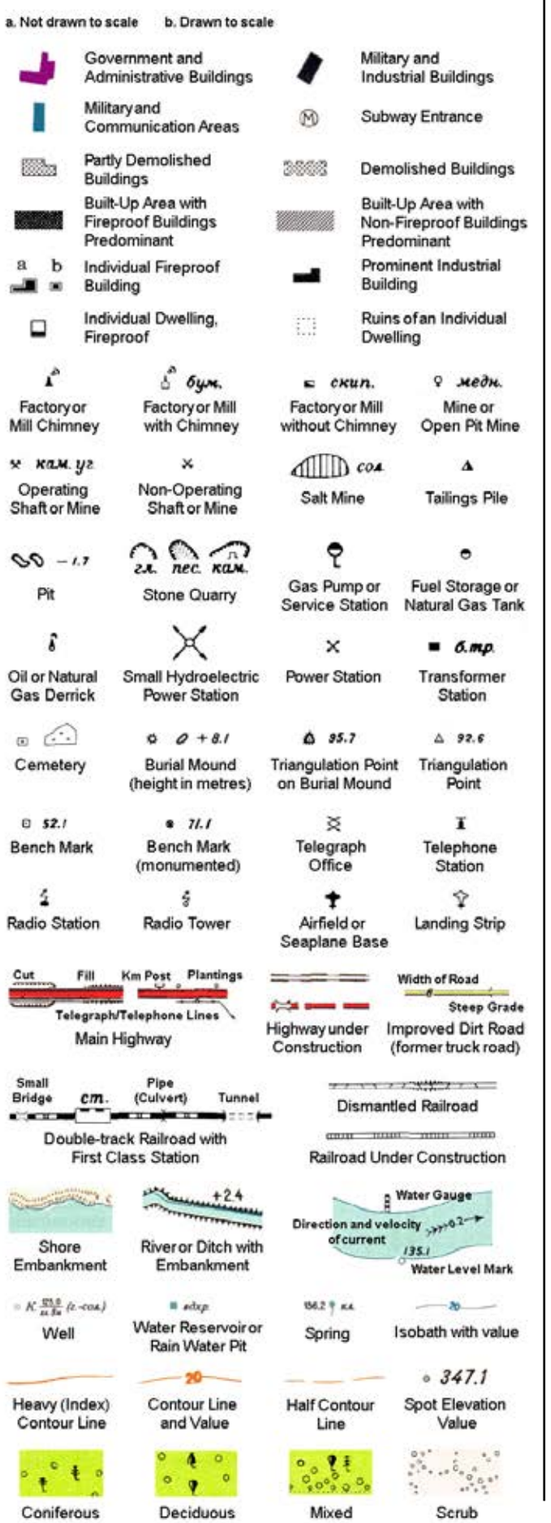
1:5,000 and 1:10,000 mapping



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



Key to Numbers on Mapping

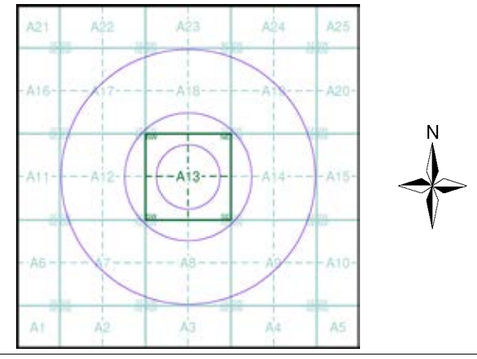
TQ76NW_Gillingham

No.	Description
31	Bridge (Road)

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Kent	1:10,560	1869	3
Kent	1:10,560	1898	4
Kent	1:10,560	1909 - 1910	5
Kent	1:10,560	1931 - 1933	6
Kent	1:10,560	1938	7
Kent	1:10,560	1938 - 1939	8
Kent	1:10,560	1939	9
Historical Aerial Photography	1:10,560	1947	10
Ordnance Survey Plan	1:10,000	1962	11
Ordnance Survey Plan	1:10,000	1968	12
Ordnance Survey Plan	1:10,000	1975	13
Gillingham	1:10,000	1984	14
Ordnance Survey Plan	1:10,000	1990	15
10K Raster Mapping	1:10,000	2006	16
10K Raster Mapping	1:10,000	2013	17

Russian Map - Slice A



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Customer Ref: GE9823
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Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

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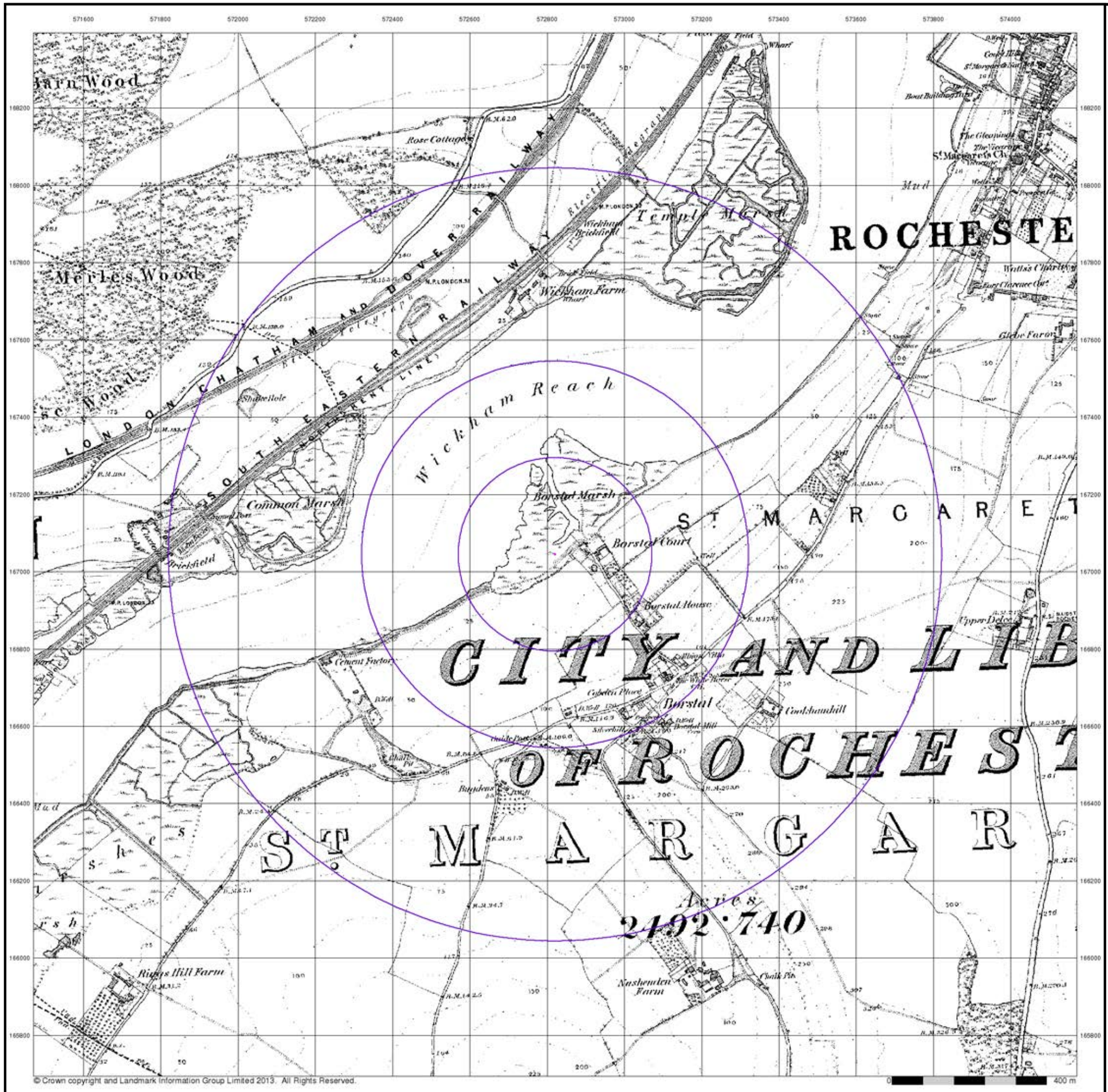

Envirocheck®

Kent

Published 1869

Source map scale - 1:10,560

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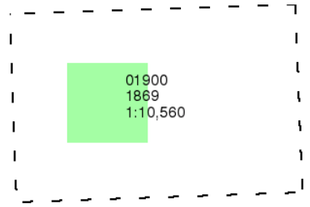
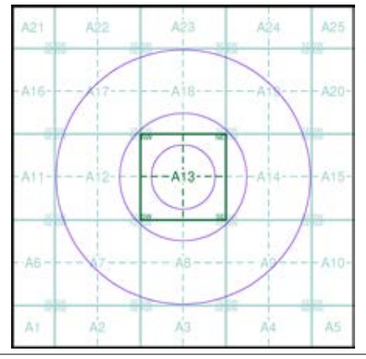
Map Name(s) and Date(s)



Historical Map - Slice A



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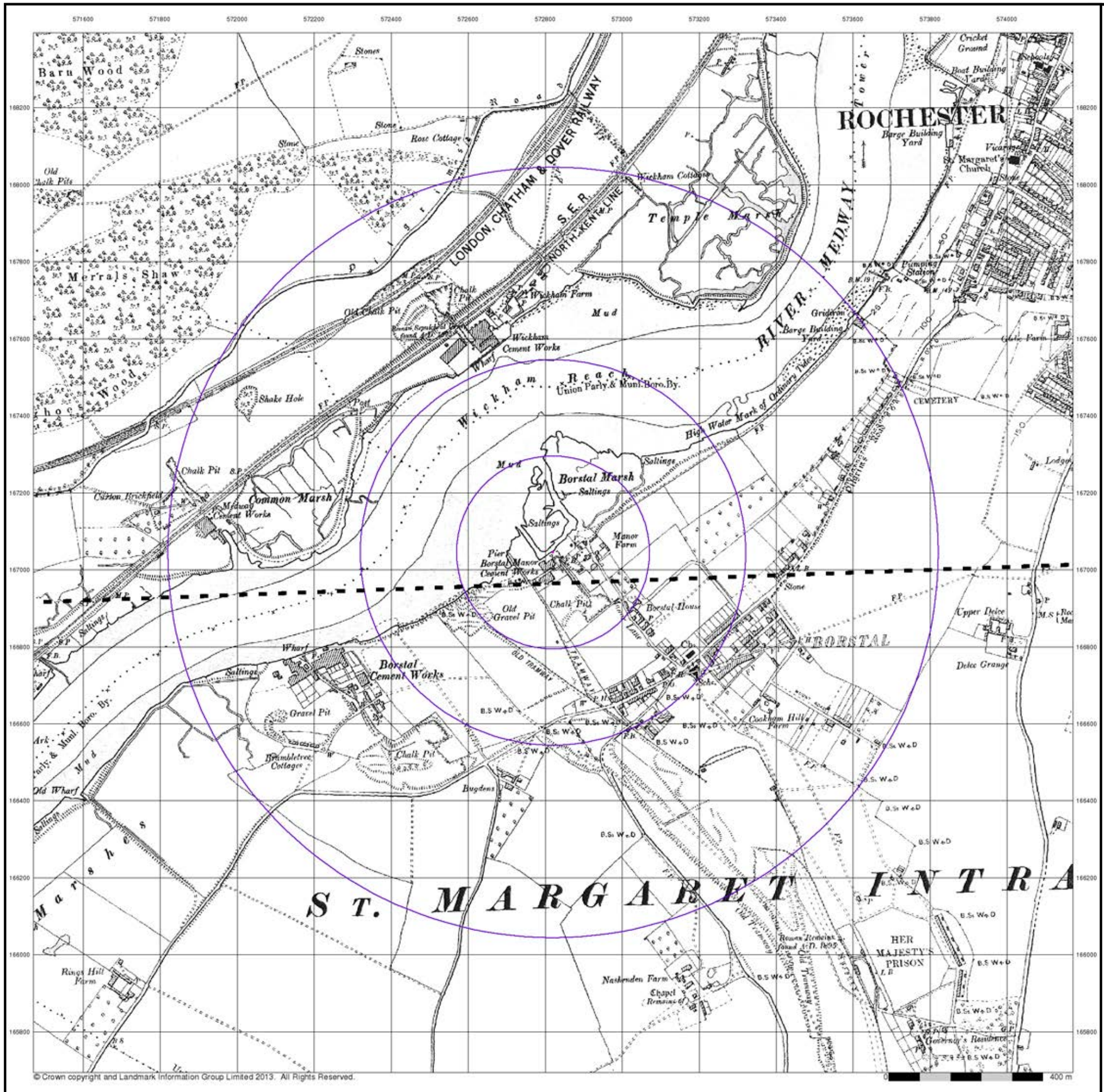

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Kent

Published 1898

Source map scale - 1:10,560

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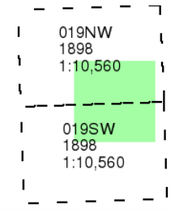
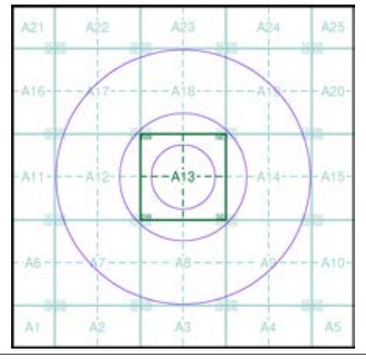
Map Name(s) and Date(s)



Historical Map - Slice A



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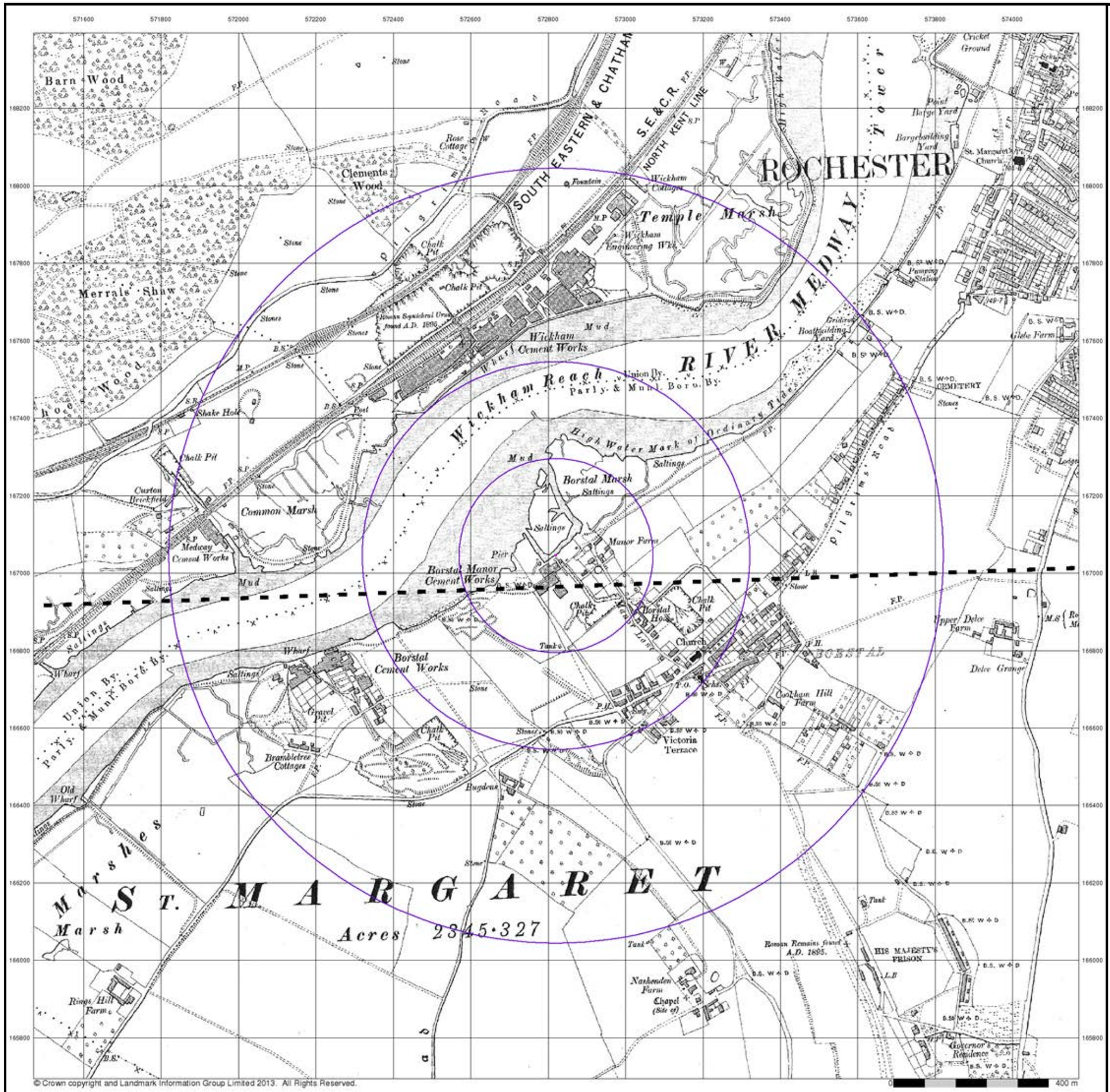

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Kent

Published 1909 - 1910

Source map scale - 1:10,560

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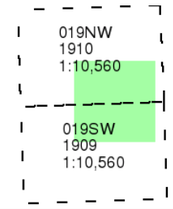
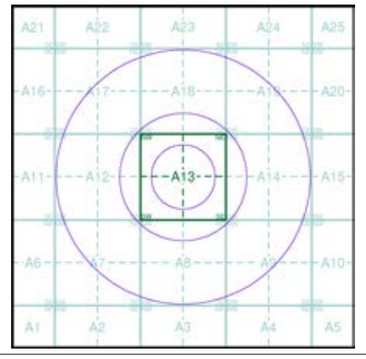
Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

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Customer Ref:	GE9823
National Grid Reference:	572820, 167040
Slice:	A
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Search Buffer (m):	1000

Site Details

Medway Bridge Maina, Rochester, ME1 3HT

Landmark Information Group

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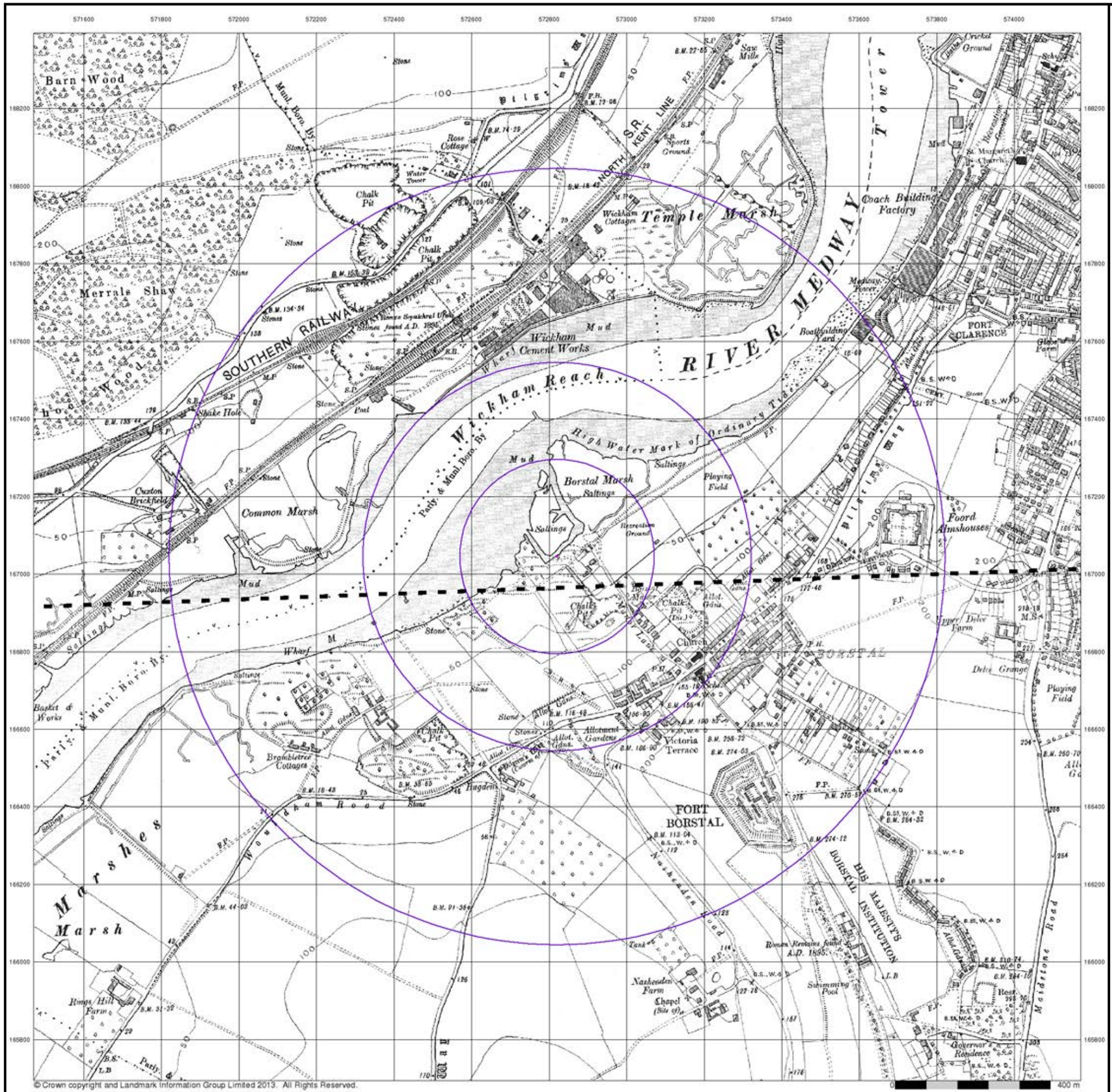
Web: www.envirocheck.co.uk



Envirocheck®

Kent

Published 1931 - 1933

Source map scale - 1:10,560

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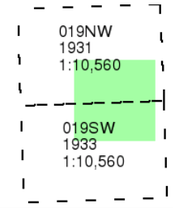
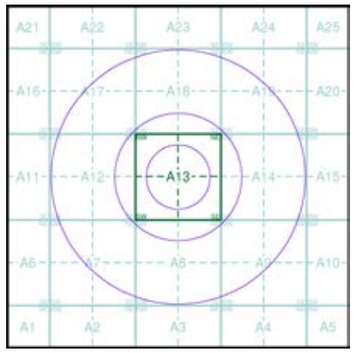
Map Name(s) and Date(s)



Historical Map - Slice A



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Order Details

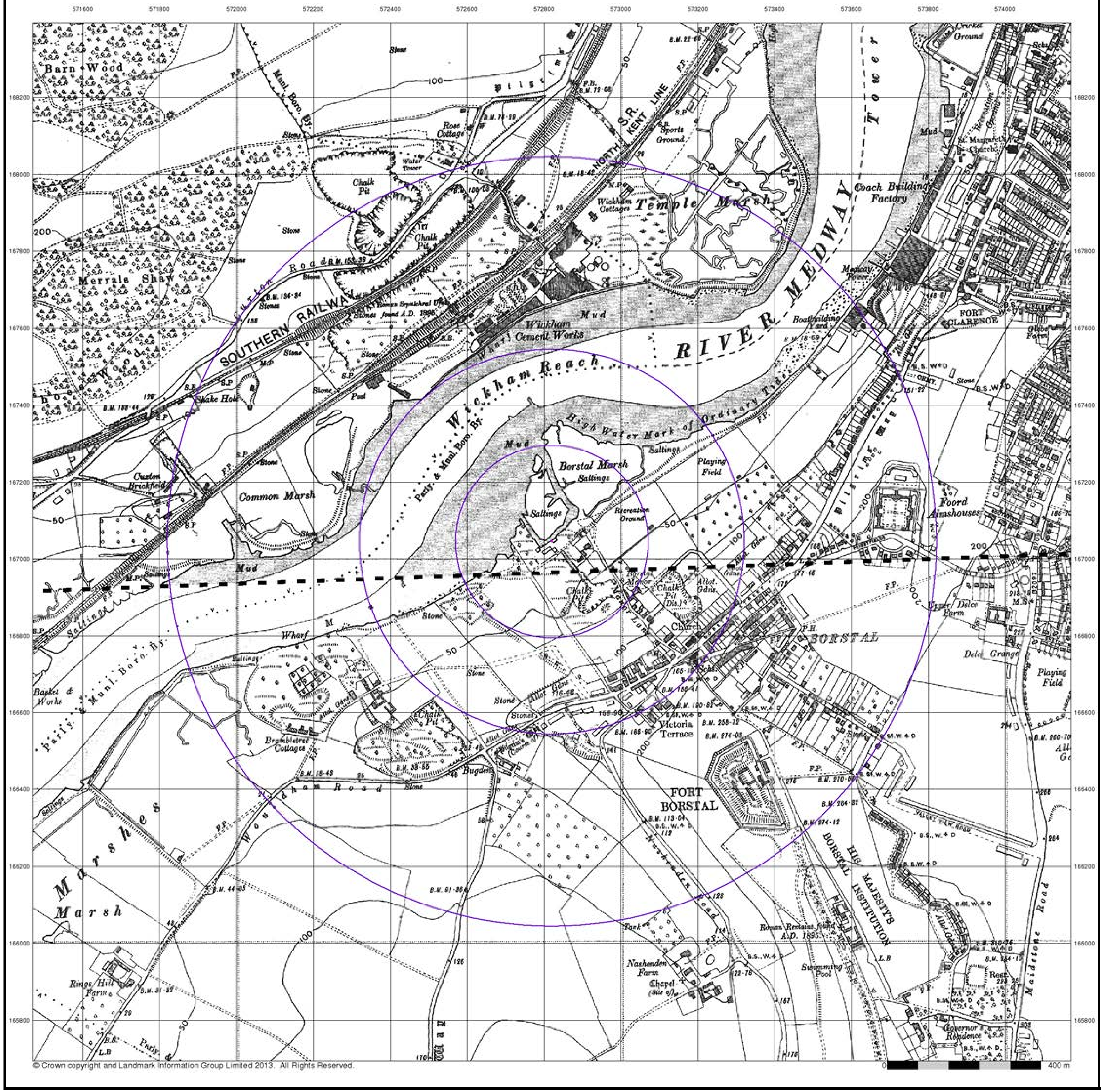
Order Number:	53195788_1_1
Customer Ref:	GE9823
National Grid Reference:	572820, 167040
Slice:	A
Site Area (Ha):	0.01
Search Buffer (m):	1000

Site Details

Medway Bridge Maina, Rochester, ME1 3HT

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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Kent

Published 1938

Source map scale - 1:10,560

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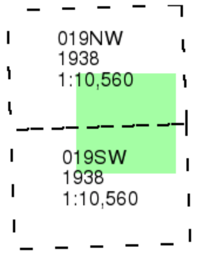
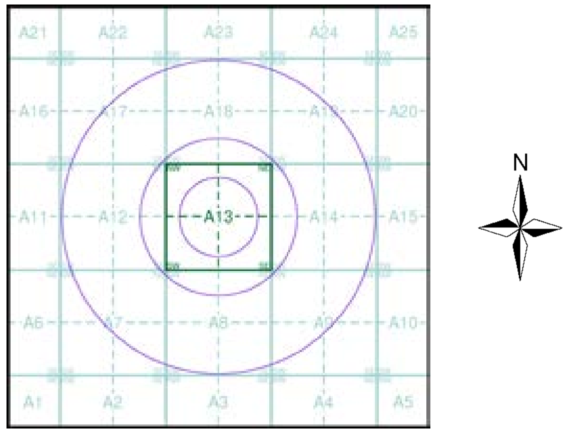
Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

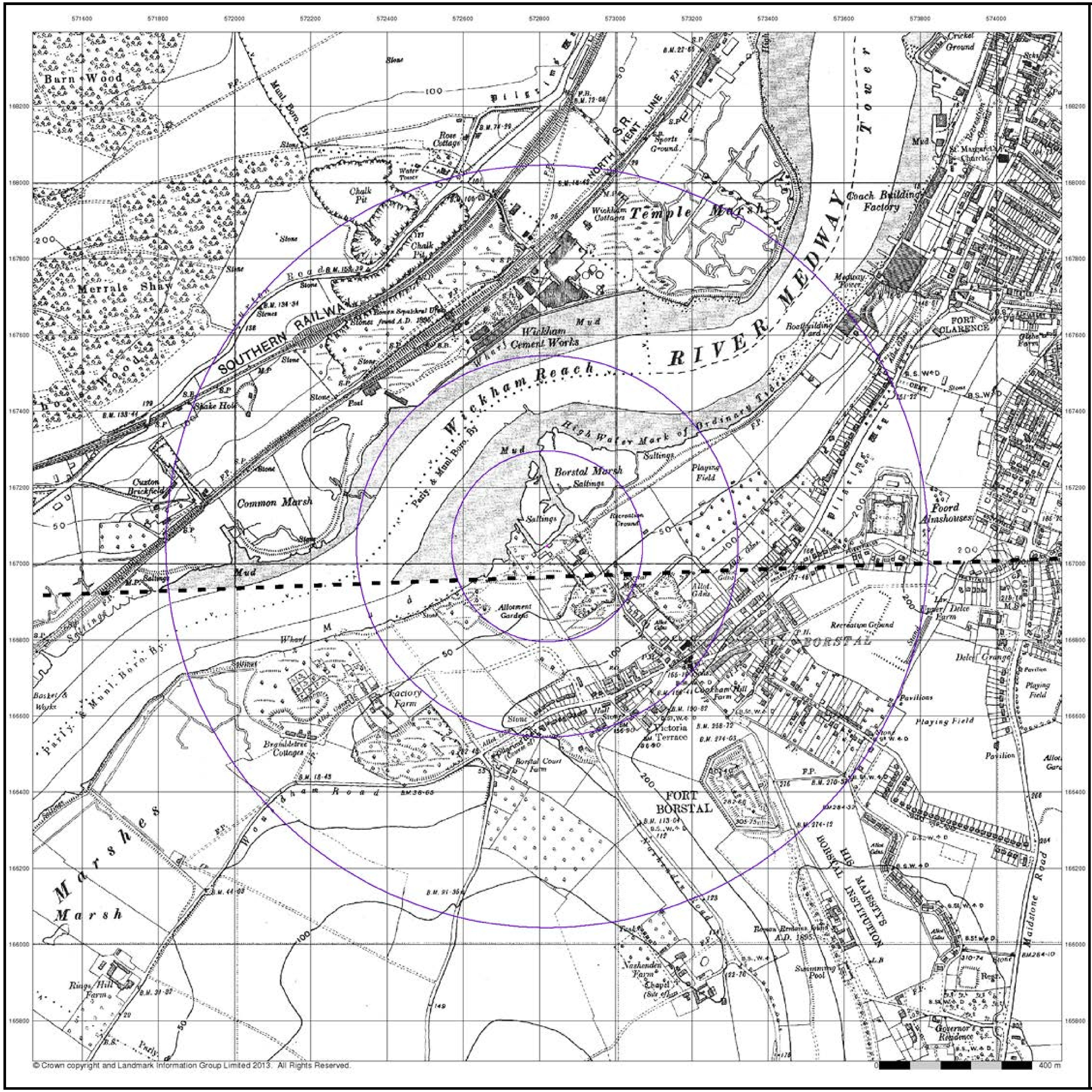
Order Number: 53195788_1_1
Customer Ref: GE9823
National Grid Reference: 572820, 167040
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

Medway Bridge Maina, Rochester, ME1 3HT

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Kent

Published 1938 - 1939

Source map scale - 1:10,560

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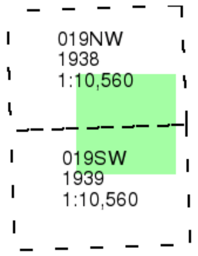
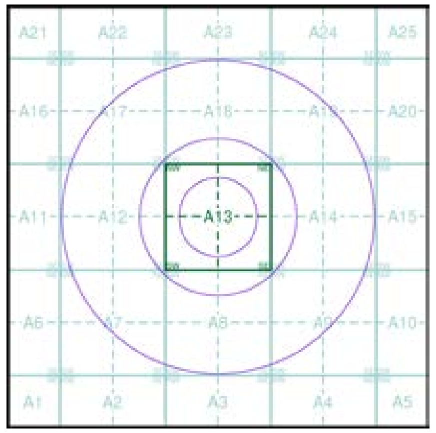


Historical Map - Slice A



Order Details

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Kent

Published 1939

Source map scale - 1:10,560

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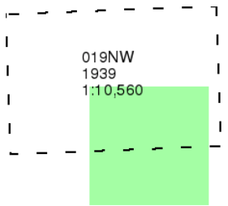
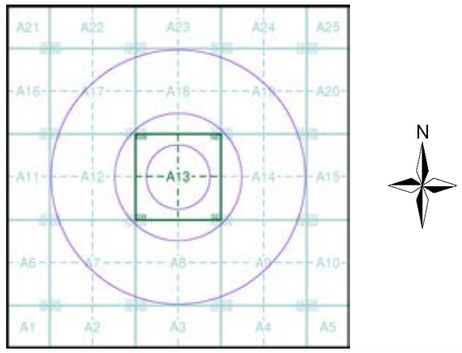
Map Name(s) and Date(s)



Historical Map - Slice A



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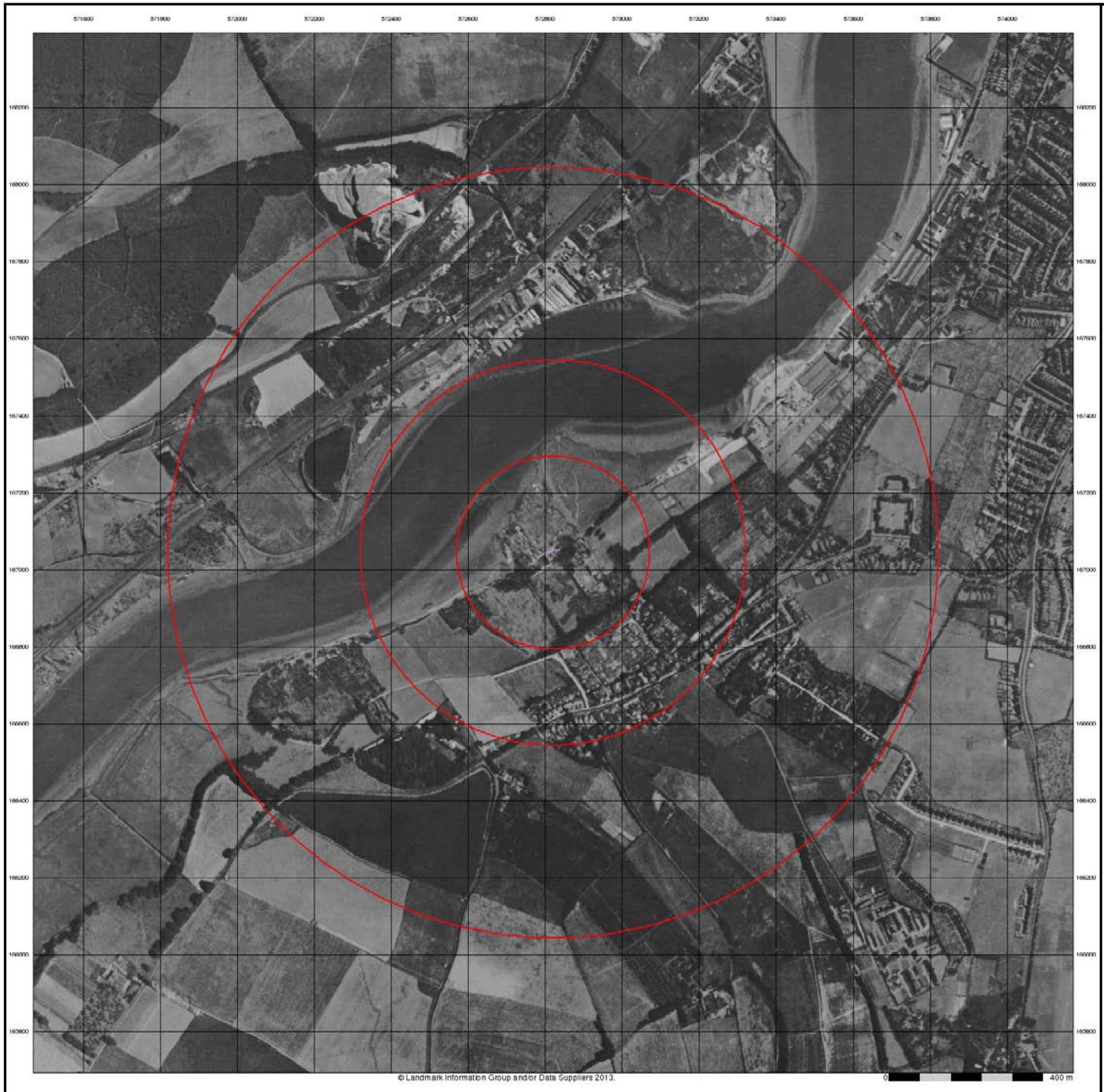
Medway Bridge Maina, Rochester, ME1 3HT



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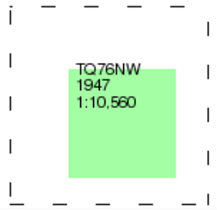
Historical Aerial Photography

Published 1947

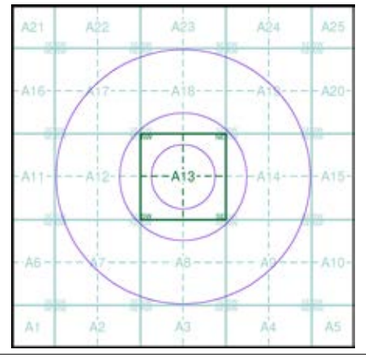
Source map scale - 1:10,560

The Historical Aerial Photos were produced by the Ordnance Survey at a scale of 1:1,250 and 1:10,560 from Air Force photography. They were produced between 1944 and 1951 as an interim measure, pending preparation of conventional mapping, due to post war resource shortages. New security measures in the 1950's meant that every photograph was re-checked for potentially unsafe information with security sites replaced by fake fields or clouds. The original editions were withdrawn and only later made available after a period of fifty years although due to the accuracy of the editing, without viewing both revisions it is not easy to spot the edits. Where available Landmark have included both revisions.

Map Name(s) and Date(s)



Historical Aerial Photography - Slice A



BRITISH LIBRARY

Order Details

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National Grid Reference:	572820, 167040
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Site Details

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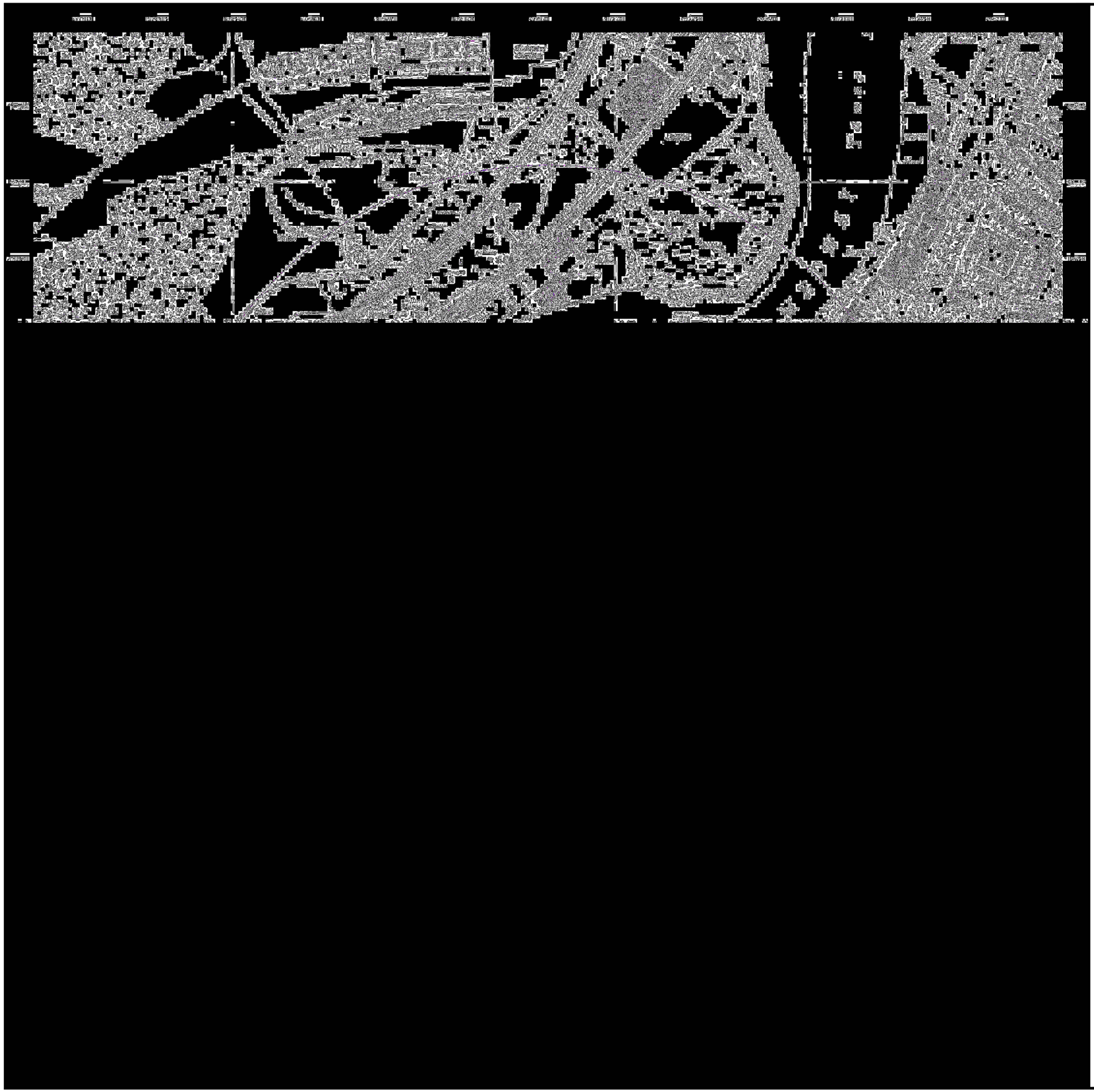

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Ordnance Survey Plan

Published 1962

Source map scale - 1:10,000

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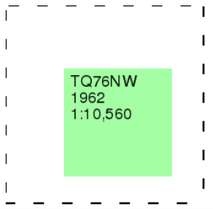
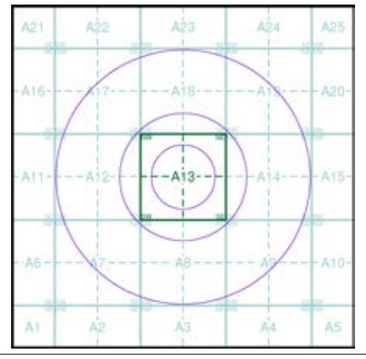
Map Name(s) and Date(s)



Historical Map - Slice A



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Ordnance Survey Plan

Published 1968

Source map scale - 1:10,000

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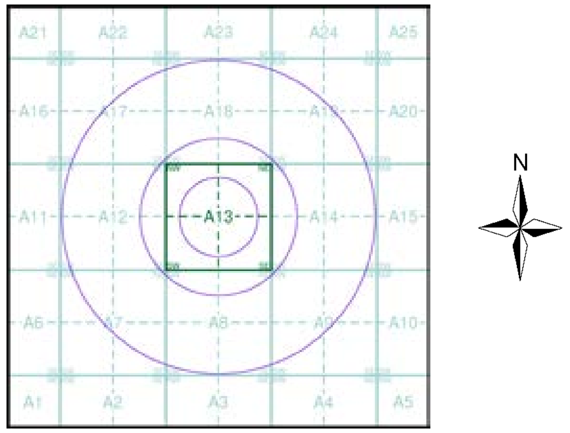
Map Name(s) and Date(s)

TQ76NW
1968
1:10,560

Historical Map - Slice A



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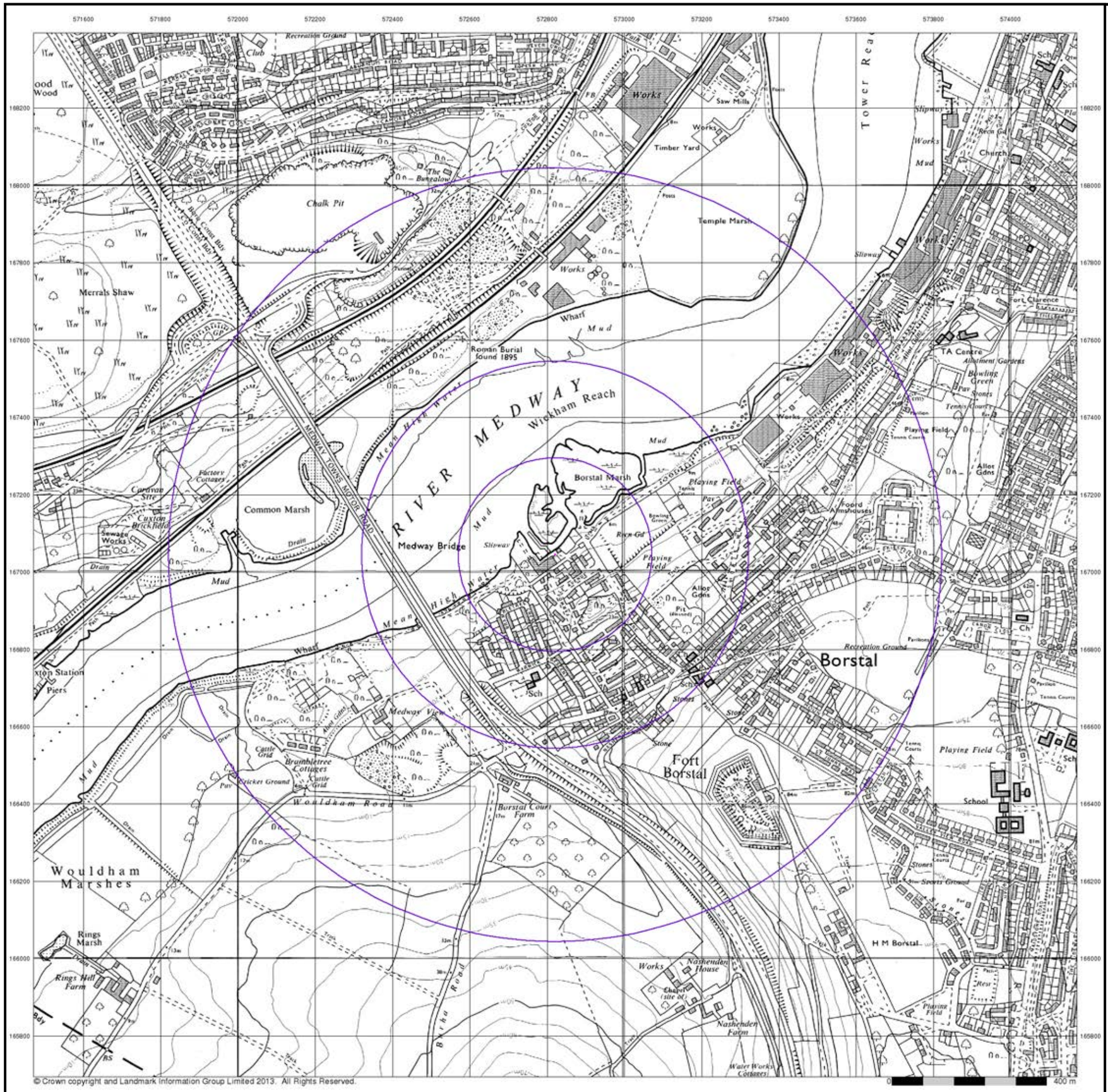

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Ordnance Survey Plan

Published 1975

Source map scale - 1:10,000

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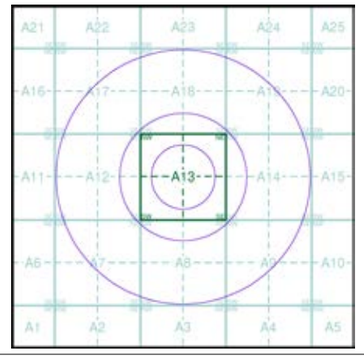
Map Name(s) and Date(s)

TQ76NW
1975
1:10,000

Historical Map - Slice A



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Gillingham

Published 1984

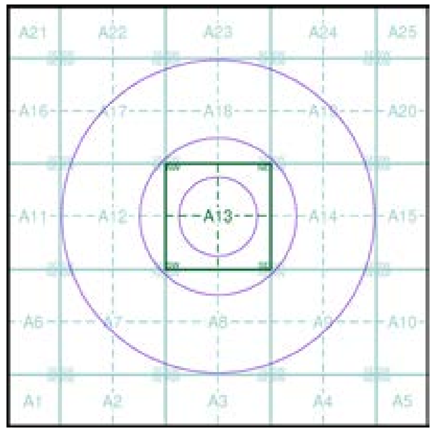
Source map scale - 1:10,000

These maps were produced by the Russian military during the Cold War between 1950 and 1997, and cover 103 towns and cities throughout the U.K. The maps are produced at 1:25,000, 1:10,000 and 1:5,000 scale, and show detailed land use, with colour-coded areas for development, green areas, and non-developed areas. Buildings are coloured black and important building uses (such as hospitals, post offices, factories etc.) are numbered, with a numbered key describing their use.
They were produced by the Russians for the benefit of navigation, as well as strategic military sites and transport hubs, for use if they were to have invaded the U.K. The detailed information provided indicates that the areas were surveyed using land-based personnel, on the ground, in the cities that are mapped.

Map Name(s) and Date(s)

TQ76NW
1984
1:10,000

Russian Map - Slice A



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