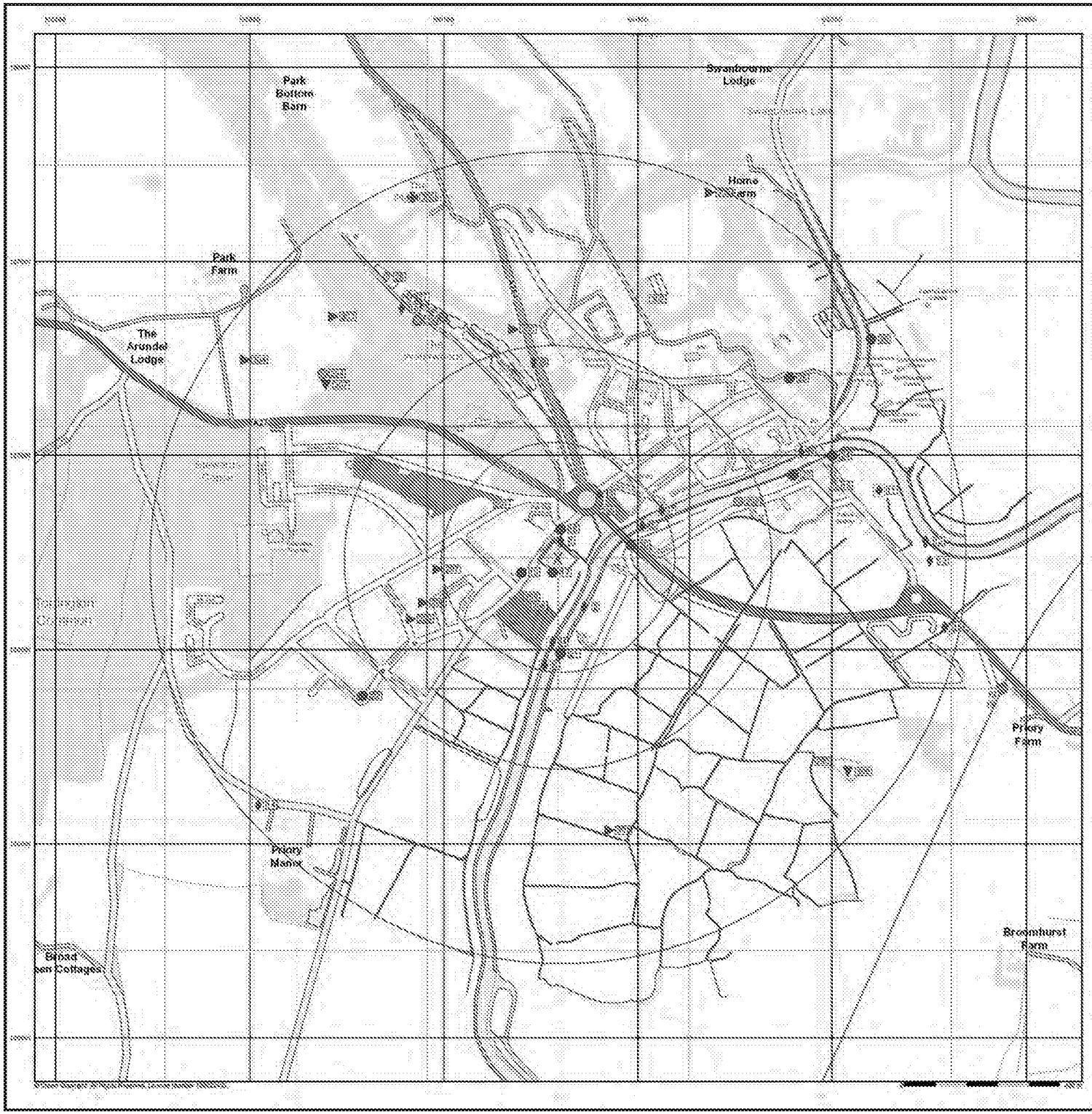
ARUN DISTRICT COUNCIL AB/88/19/PL



RSK

General
Specified Site | Specified Buffer(s) | Bearing Reference Point | Map ID
Several of Type at Location

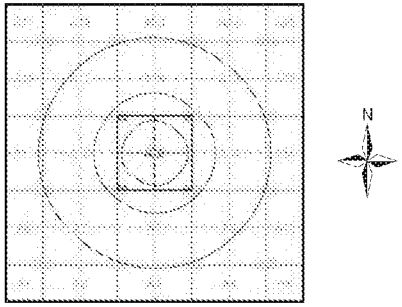
Agency and Hydrological
Contaminated Land Register Entry or Notice (Location)
Contaminated Land Register Entry or Notice
Discharge Consent
Enforcement or Prohibition Notice
Integrated Pollution Control
Integrated Pollution Prevention Control
Local Authority Integrated Pollution Prevention and Control
Local Authority Pollution Prevention and Control
Local Authority Pollution Prevention and Control Enforcement
Pollution Incident to Controlled Waters
Prosecution Relating to Authorised Processes
Prosecution Relating to Controlled Waters
Registered Radioactive Substance
River Network or Water Feature
River Quality Sampling Point
Substantiated Pollution Incident Register
Water Abstraction
Water Industry Act Referral

Hazardous Substances
COMAH Site | Explosive Site
NIHHS Site
Planning Hazardous Substance Consent
Planning Hazardous Substance Enforcement

Geological
BGS Recorded Mineral Site

Waste
BGS Recorded Landfill Site (Location)
BGS Recorded Landfill Site
EA Historic Landfill (Buffered Point)
EA Historic Landfill (Polygon)
Integrated Pollution Control Registered Waste Site
Licensed Waste Management Facility (Landfill Boundary)
Licensed Waste Management Facility (Location)
Local Authority Recorded Landfill Site (Location)
Local Authority Recorded Landfill Site
Potentially Infilled Land (Non-Water)
Potentially Infilled Land (Non-Water)
Potentially Infilled Land (Non-Water)
Potentially Infilled Land (Water)
Potentially Infilled Land (Water)
Potentially Infilled Land (Water)
Registered Landfill Site
Registered Landfill Site (Location)
Registered Landfill Site (Point Buffered to 100m)
Registered Landfill Site (Point Buffered to 250m)
Registered Waste Transfer Site (Location)
Registered Waste Transfer Site
Registered Waste Treatment or Disposal Site (Location)
Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Slice A



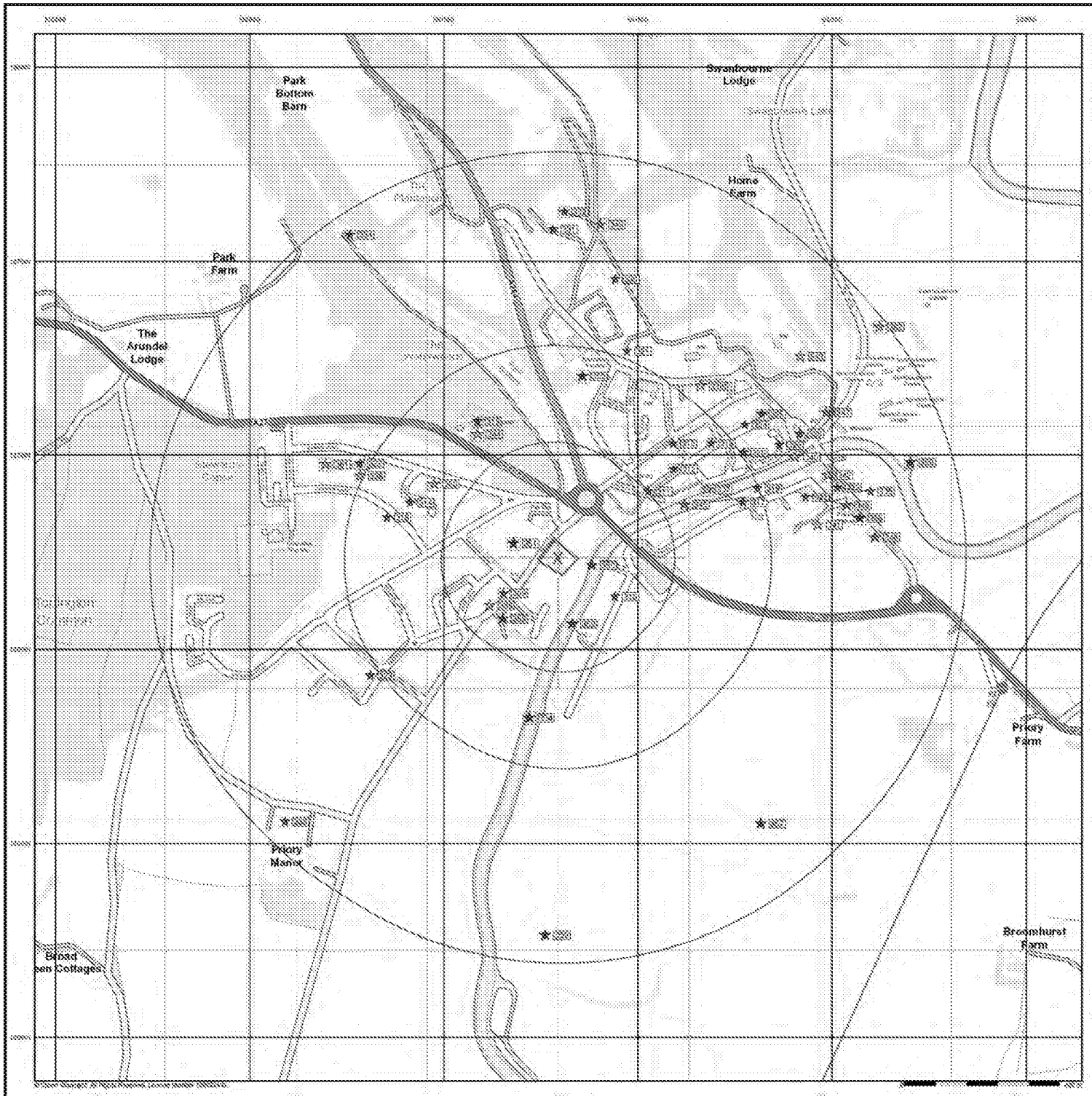
Order Details

Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

Site Details

5, Ford Road, ARUNDEL, BN18 9DX

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



Industrial Land Use Map

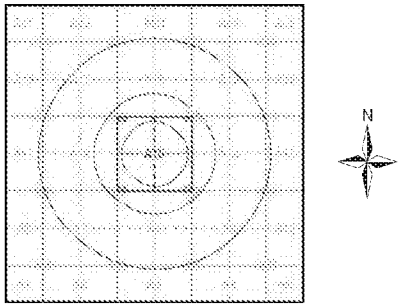
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry
- Gas Pipeline
- Points of Interest - Commercial Services
- Points of Interest - Education and Health
- Points of Interest - Manufacturing and Production
- Points of Interest - Public Infrastructure
- Points of Interest - Recreational and Environmental
- Underground Electrical Cables

Industrial Land Use Map - Slice A



Order Details

Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
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Search Buffer (m):	1000

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RSK

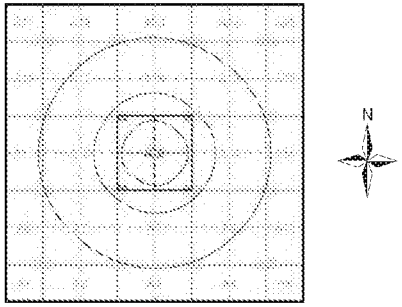
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



Order Details

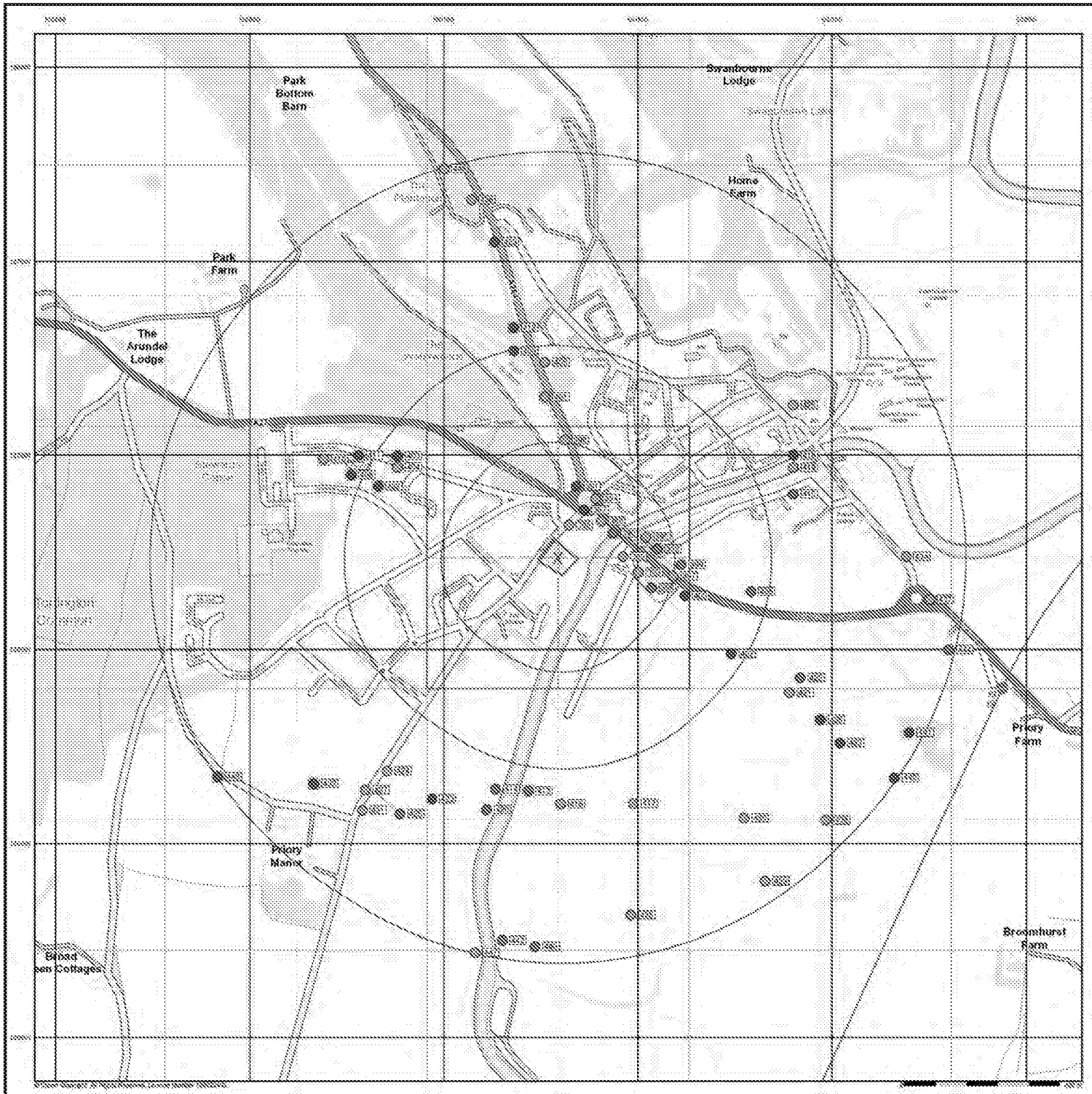
Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

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ARUN DISTRICT COUNCIL AB/88/19/PL



RSK

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID
- Several of Type at Location

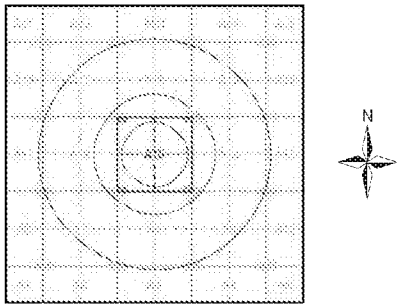
Agency and Hydrological (Boreholes)

- BGS Borehole Depth 0 - 10m
- BGS Borehole Depth 10 - 30m
- BGS Borehole Depth 30m +
- Confidential
- Other

For Borehole information please refer to the Borehole .csv file which accompanied this slice.

A copy of the BGS Borehole Ordering Form is available to download from the Support section of www.envirocheck.co.uk.

Borehole Map - Slice A



Order Details

Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

Site Details

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



RSK

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

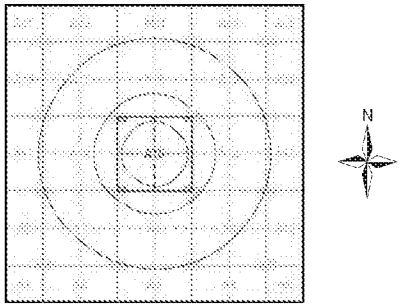
OS Water Network Data

- Canal
- Reservoir
- Foreshore
- Marsh
- Tidal River
- Inland River
- Drain
- Other
- Lake
- Transfer
- Lock Or Flight Of Locks
- Sea

Contours (height in meters)

- Standard Contour
- Master Contour
- Spot Height
- Mean Low Water
- Mean High Water

OS Water Network Map - Slice A



Order Details

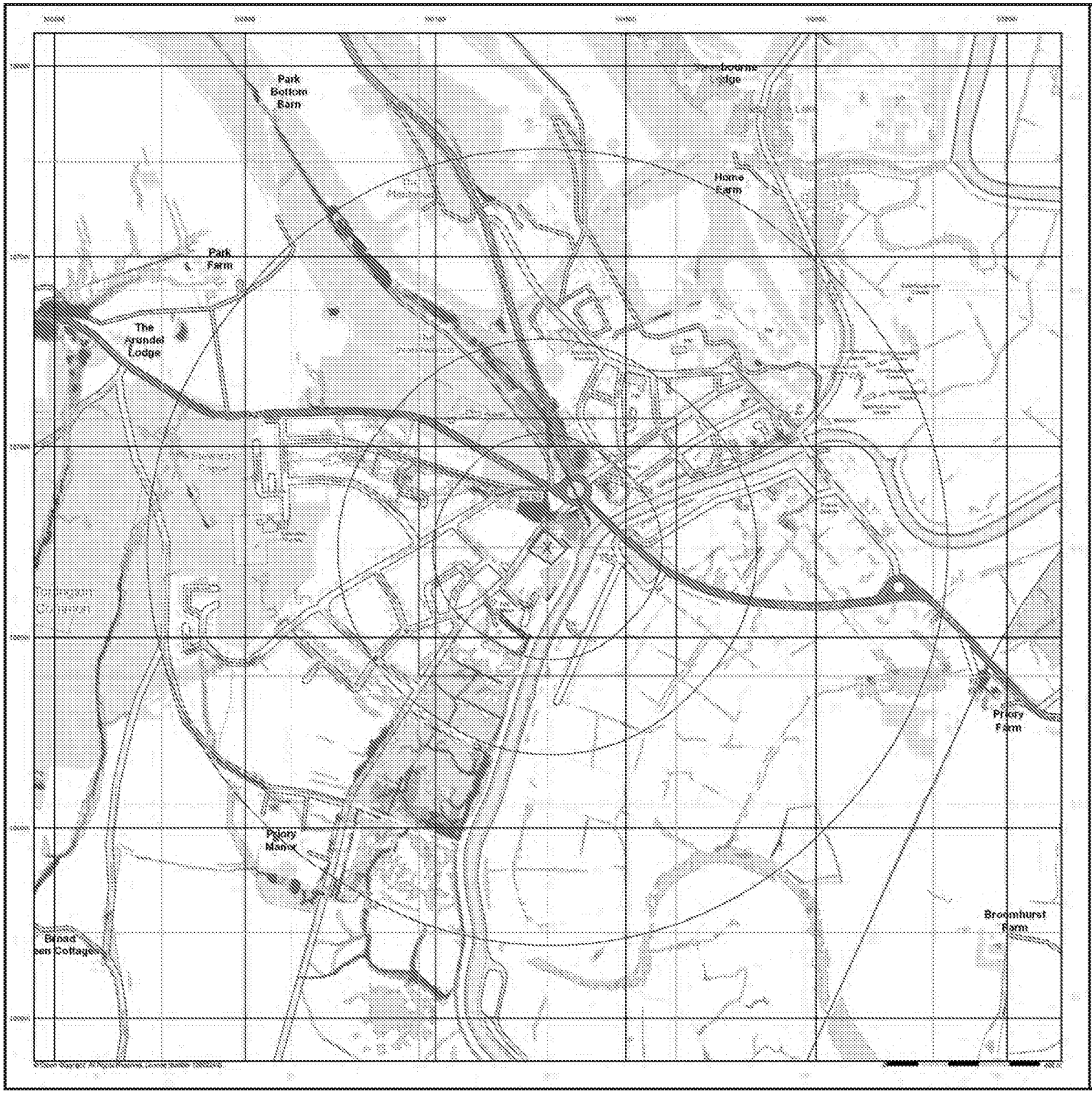
Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

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ARUN DISTRICT COUNCIL AB/88/19/PL



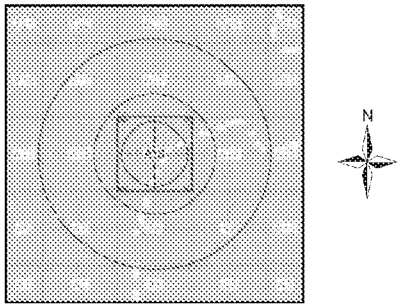
RSK

General
- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Risk of Flooding from Surface Water
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability
See the suitability map below
- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

EA/NRW Suitability Map - Slice A



Order Details

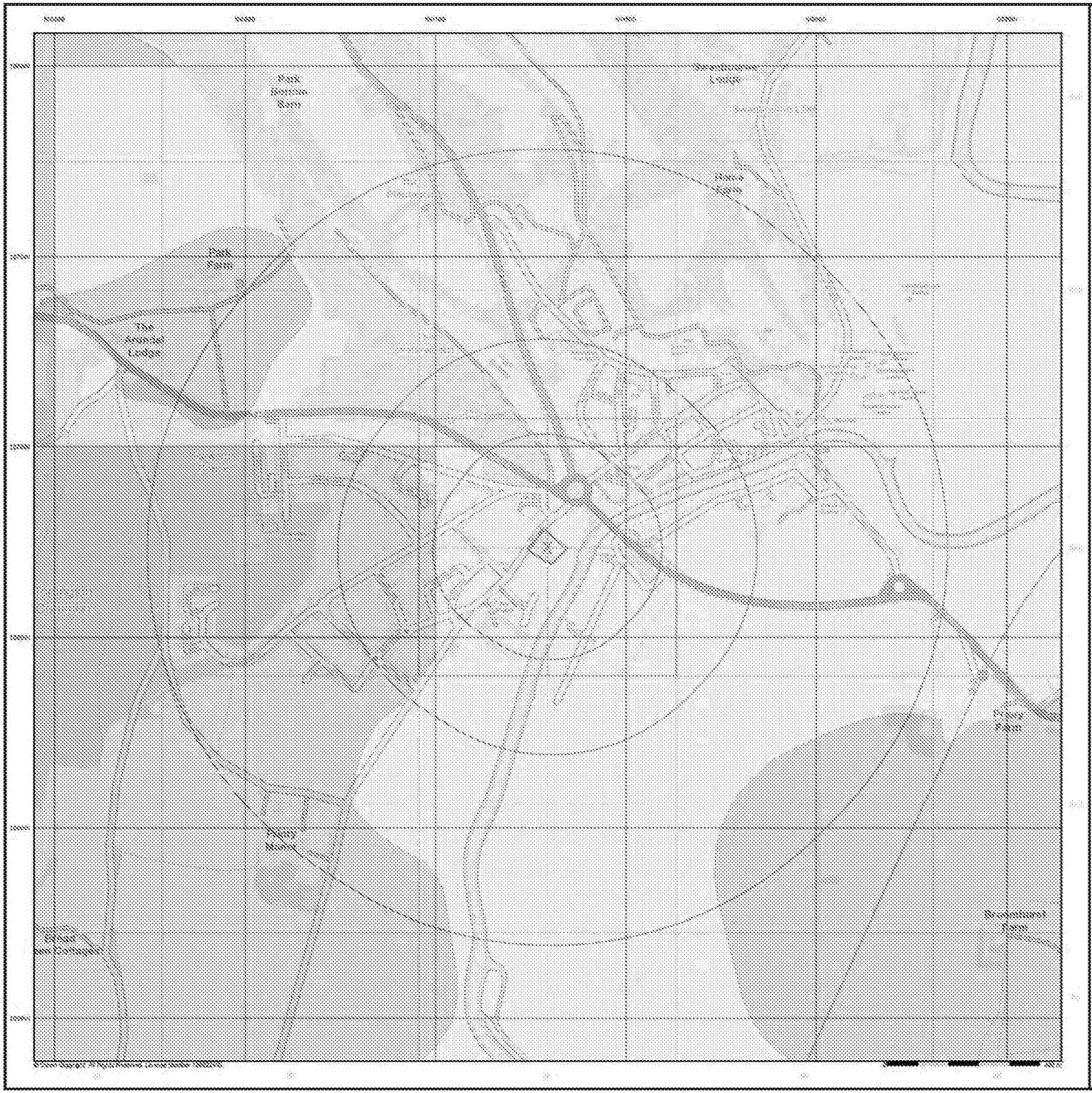
Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
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ARUN DISTRICT COUNCIL AB/88/19/PL



General

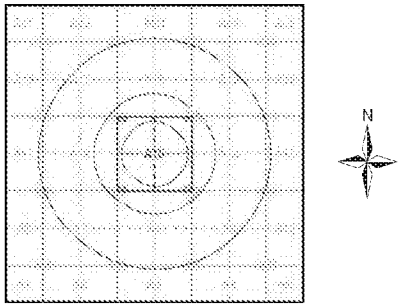
Specified Site | Specified Buffer(s) | Bearing Reference Point

Estimated Soil Chemistry Arsenic

Arsenic Concentrations mg/kg

- < 15
- 15 - 25
- 25 - 35
- 35 - 45
- 45 - 60
- 60 - 120
- > 120

Estimated Soil Chemistry Arsenic - Slice A



Order Details

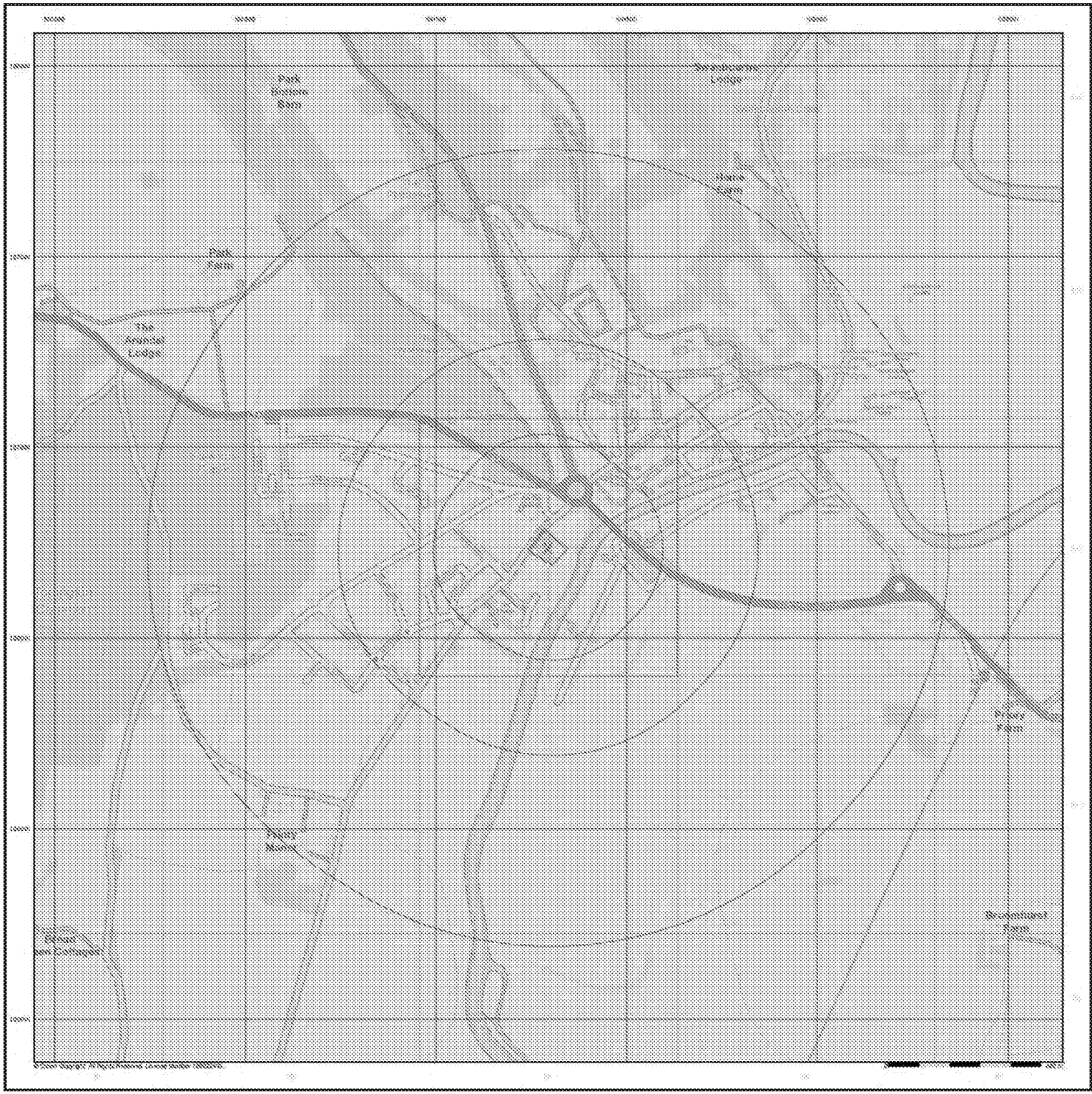
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Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

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Web: www.envirocheck.co.uk

ARUN DISTRICT COUNCIL AB/88/19/PL



General

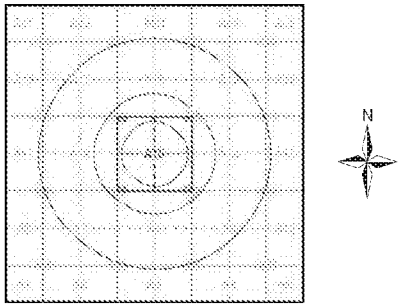
Specified Site | Specified Buffer(s) | Bearing Reference Point

Estimated Soil Chemistry Cadmium

Cadmium Concentrations mg/kg

- < 1.8
- 1.8 - 2.2
- 2.2 - 3.0
- > 3.0

Estimated Soil Chemistry Cadmium - Slice A



Order Details

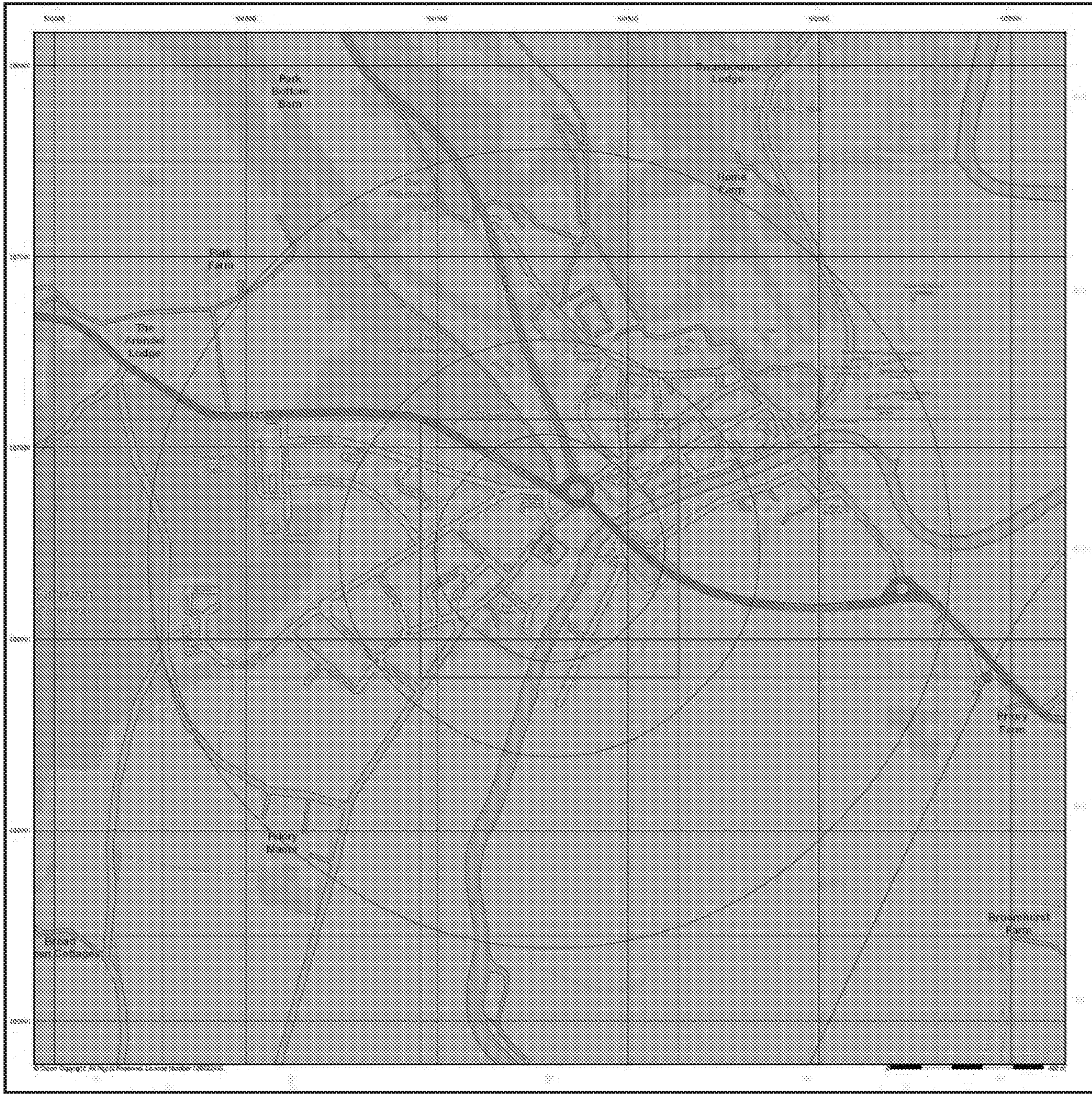
Order Details:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
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ARUN DISTRICT COUNCIL AB/88/19/PL



General

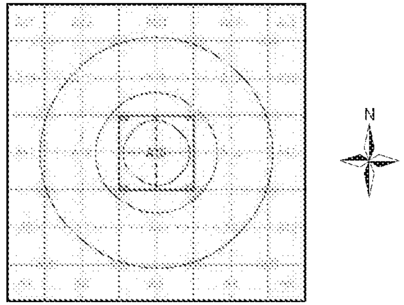
Specified Site Specified Buffer(s) Bearing Reference Point

Estimated Soil Chemistry Chromium

Chromium Concentrations mg/kg

- < 20
- 20 - 40
- 40 - 60
- 60 - 90
- 90 - 120
- 120 - 180
- > 180

Estimated Soil Chemistry Chromium - Slice A



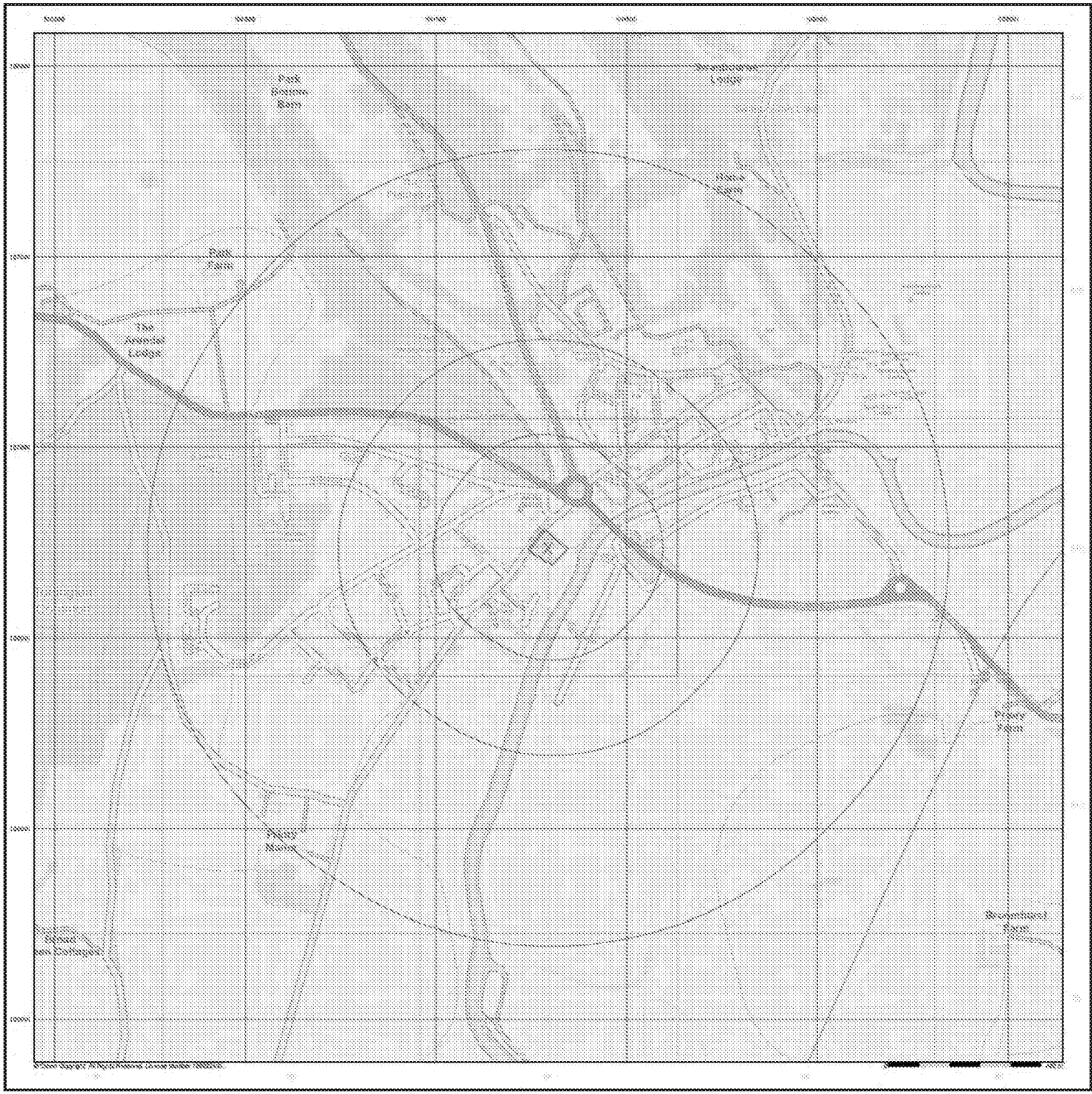
Order Details

Order Details:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

Site Details

5, Ford Road, ARUNDEL, BN18 9DX

ARUN DISTRICT COUNCIL AB/88/19/PL



General

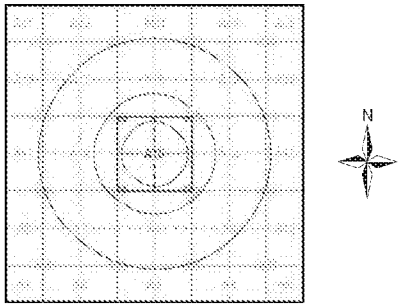
Specified Site | Specified Buffer(s) | Bearing Reference Point

Estimated Soil Chemistry Lead

Lead Concentrations mg/kg

- <100 mg/kg
- 100 - 200
- 200 - 300
- 300 - 600
- 600 - 1200
- >1200

Estimated Soil Chemistry Lead - Slice A



Order Details

Order Details:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

Site Details

5, Ford Road, ARUNDEL, BN18 9DX

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



General

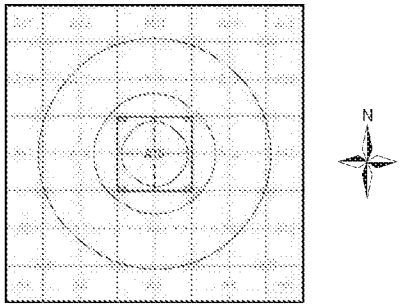
Specified Site | Specified Buffer(s) | Bearing Reference Point

Estimated Soil Chemistry Nickel

Nickel Concentrations mg/kg

- < 15
- 15 - 30
- 30 - 45
- 45 - 60
- 60 - 80
- 80 - 100
- > 100

Estimated Soil Chemistry Nickel - Slice A



Order Details

Order Details:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Slice:	A
Site Area (Ha):	0.47
Search Buffer (m):	1000

Site Details

5, Ford Road, ARUNDEL, BN18 9DX

Landmark Information Group

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Historical Mapping Legends

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

Quarry
Gravel Pit
Sand Pit
Clay Pit
Shingle
Refuse Heap
Sloping Masonry
Flat Rock
Marsh
Reeds
Osiers
Rough Pasture
Furze
Wood
Mixed Wood
Brushwood
Orchard
Fir
Ford
Stepping Stones
Ferry
Waterfall
Lock
Trig. Station
507 Altitude at Trig. Station
B.M.325.9 Bench Mark
348 Surface Level
Arrow denotes flow of water
Antiquities (site of)
Cutting
Embankment
Railway crossing Road
Level Crossing
Road crossing Railway
Railway crossing River or Canal
Road over single stream
Road over River or Canal

County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
County Borough Boundary (England)
Co. Boro. Bdy.
County Burgh Boundary (Scotland)
Co. Burgh Bdy.

B.S B.S	Boundary Post or Stone	P.C.B	Police Call Box
B.S.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F.B.	Foot Bridge	Sl.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.S	Mooring Post or Ring	W	Well

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

Inactive Quarry, Chalk Pit or Clay Pit
Active Quarry, Chalk Pit or Clay Pit
Rock
Boulders
Cliff
Slopes
Top
Top
Roofed Building
Glazed Roof Building
Top
Sloping Masonry
Archway
Non-Coniferous Tree (surveyed)
Coniferous Tree (surveyed)
Non-Coniferous Trees (not surveyed)
Coniferous Trees (not surveyed)
Orchard Tree
Scrub
Bracken
Coppice, Osier
Reeds
Marsh, Saltings
Rough Grassland
Heath
Culvert
Direction of water flow
B M Bench Mark
Antiquity (site of)
Cave Entrance
Triangulation Station
Electricity Pylon
Electricity Transmission Line

County Boundary (Geographical)
County & Civil Parish Boundary
Civil Parish Boundary
Admin. County or County Bor. Boundary
L B Bdy
London Borough Boundary
Symbol marking point where boundary mereing changes

BH	Beer House	P	Pillar, Pole or Post
BP, BS	Boundary Post or Stone	PO	Post Office
Cn. C	Capstan, Crane	PC	Public Convenience
Chy	Chimney	PH	Public House
D Fn	Drinking Fountain	Pp	Pump
El P	Electricity Pillar or Post	SB, S Br	Signal Box or Bridge
FAP	Fire Alarm Pillar	SP, SL	Signal Post or Light
FB	Foot Bridge	Spr	Spring
GP	Guide Post	Tk	Tank or Track
H	Hydrant or Hydraulic	TCB	Telephone Call Box
LC	Level Crossing	TCP	Telephone Call Post
MH	Manhole	Tr	Trough
MP	Mile Post or Mooring Post	Wr Pt, Wr T	Water Point, Water Tap
MS	Mile Stone	W	Well
NTL	Normal Tidal Limit	Wd Pp	Wind Pump

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

Slopes
Top
Top
Cliff
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Positioned Boulder
Scree
Non-Coniferous Tree (surveyed)
Coniferous Tree (surveyed)
Non-Coniferous Trees (not surveyed)
Coniferous Trees (not surveyed)
Orchard Tree
Scrub
Bracken
Coppice, Osier
Reeds
Marsh, Saltings
Rough Grassland
Heath
Culvert
Direction of water flow
Triangulation Station
Antiquity (site of)
Electricity Transmission Line
Electricity Pylon
BH 23.60m Bench Mark
Buildings with Building Seed
Roofed Building
Glazed Roof Building

Civil parish/community boundary
District boundary
County boundary
Boundary post/stone
Boundary mereing symbol (note: these always appear in opposed pairs or groups of three)

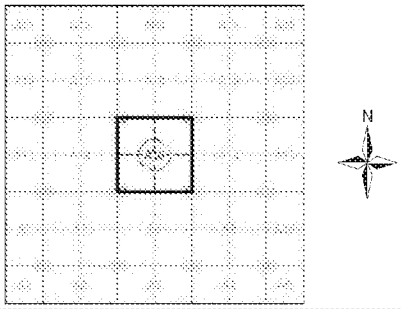
Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Disantd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity Pole, Pillar	SB, S Br	Signal Box or Bridge
El Sub Sta	Electricity Sub Station	SP, SL	Signal Post or Light
FB	Filter Bed	Spr	Spring
Fn / D Fn	Fountain / Drinking Ftn.	Tk	Tank or Track
Gas Gov	Gas Valve Compound	Tr	Trough
GVC	Gas Governor	Wd Pp	Wind Pump
GP	Guide Post	Wr Pt, Wr T	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

RSK

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Sussex	1:2,500	1876	2
Sussex	1:2,500	1897	3
Sussex	1:2,500	1912	4
Sussex	1:2,500	1937 - 1940	5
Ordnance Survey Plan	1:2,500	1971	6
Supply of Unpublished Survey Information	1:2,500	1973	7
Supply of Unpublished Survey Information	1:2,500	1974	8
Additional SIMs	1:2,500	1977	9
Ordnance Survey Plan	1:2,500	1979 - 1980	10
Additional SIMs	1:2,500	1988 - 1989	11
Additional SIMs	1:2,500	1991	12
Large-Scale National Grid Data	1:2,500	1994	13
Historical Aerial Photography	1:2,500	1999	14

Historical Map - Segment A13



Order Details

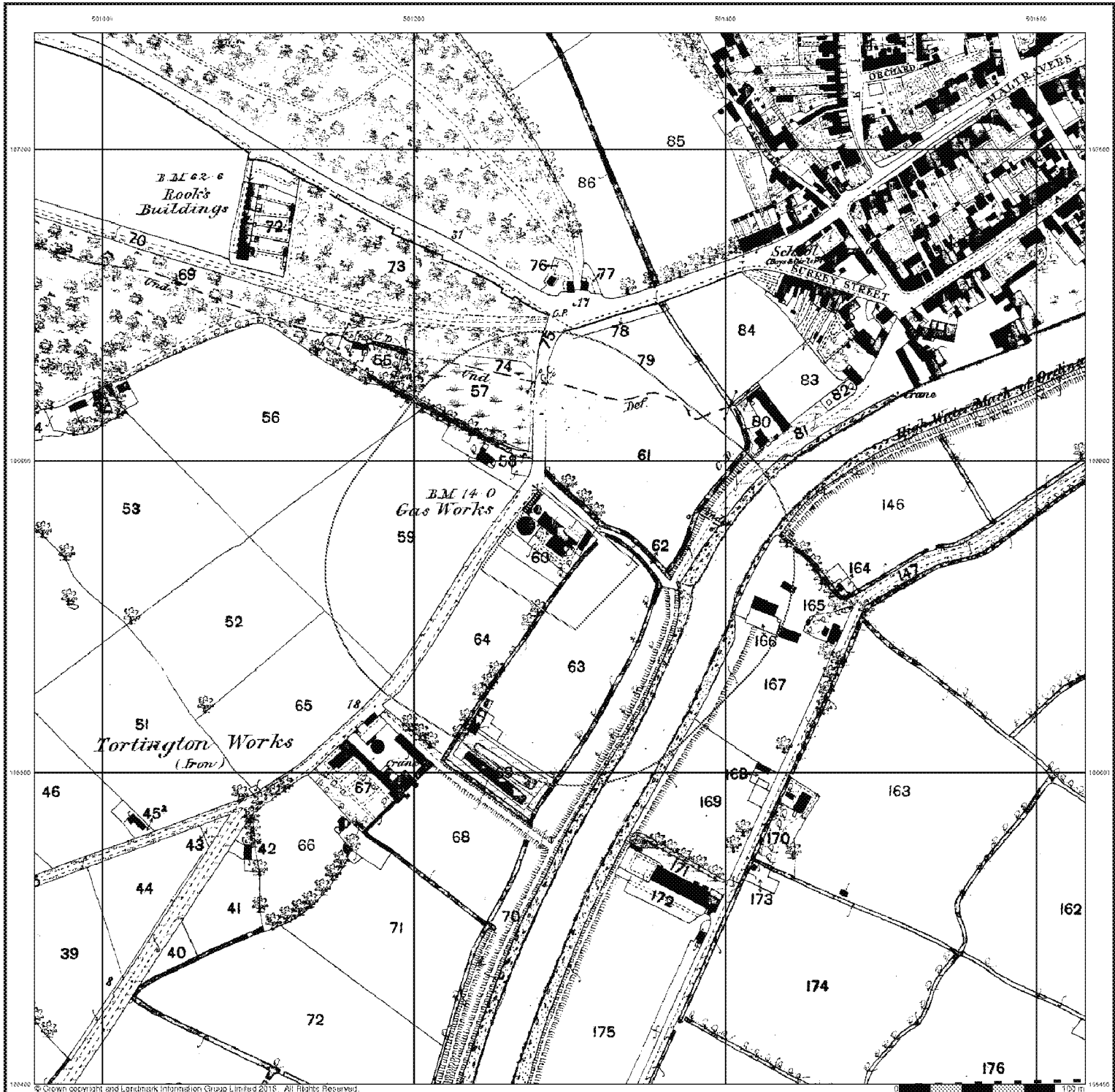
Order Number: 158393817_1_1
Customer Ref: 29780
National Grid Reference: 501290, 106740
Slice: A
Site Area (Ha): 0.47
Search Buffer (m): 100

Site Details

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Landmark Information Group
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ARUN DISTRICT COUNCIL AB/88/19/PL



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RSK

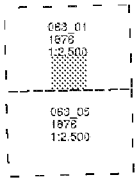
Sussex

Published 1876

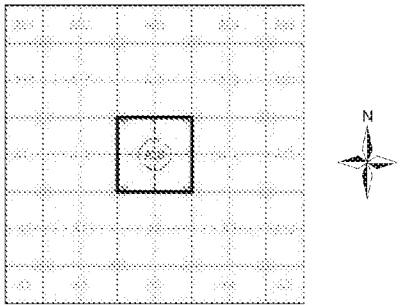
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1936, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

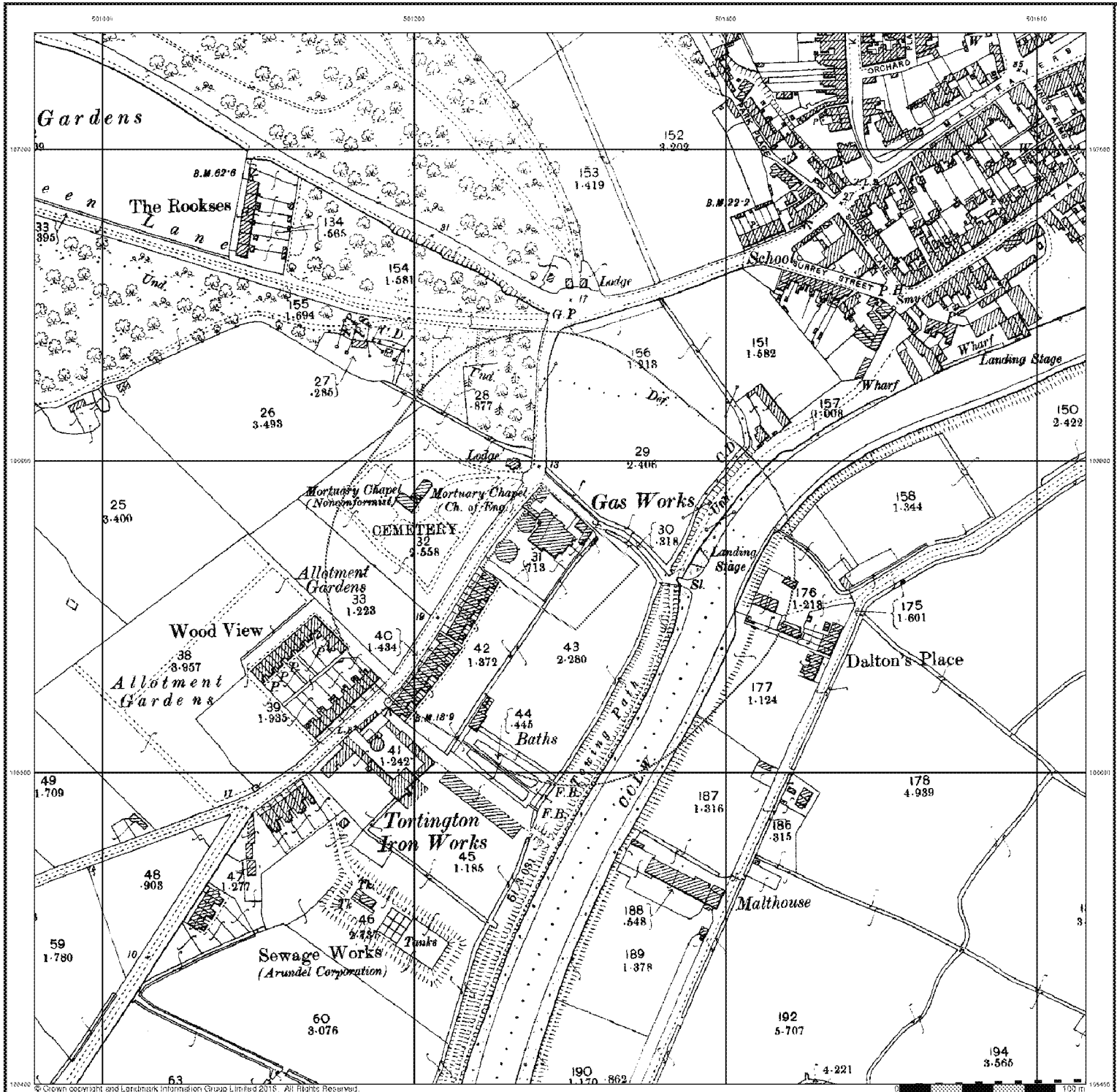
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Customer Ref:	29780
National Grid Reference:	501290, 106740
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Search Buffer (m):	100

Site Details

5, Ford Road, ARUNDEL, BN18 9DX

Landmark Information Group

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Web: www.envirocheck.co.uk



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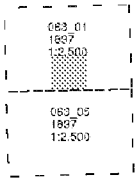
Sussex

Published 1897

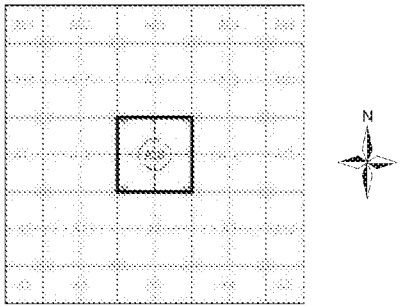
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered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

Map Name(s) and Date(s)



Historical Map - Segment A13



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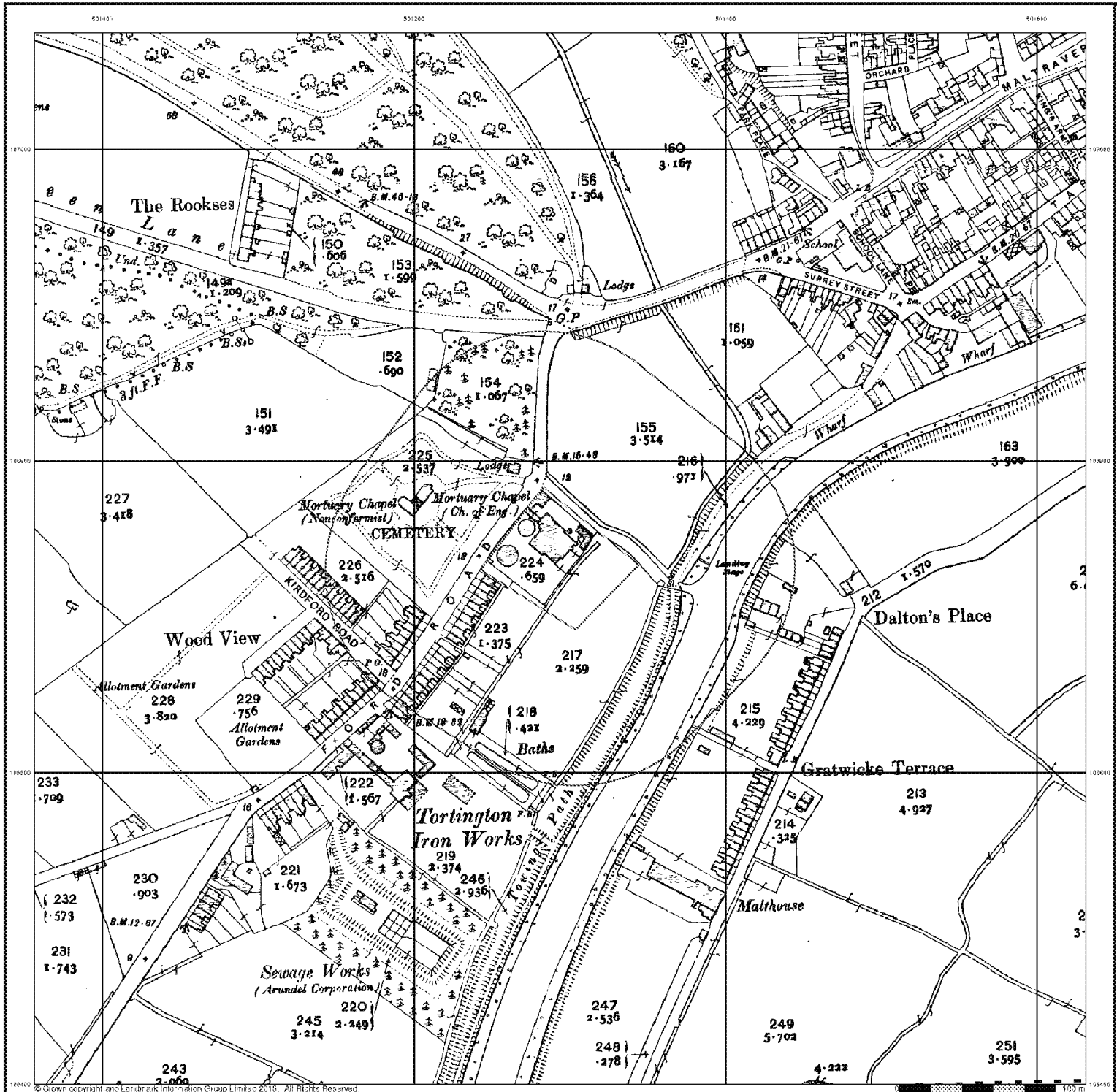
Site Details

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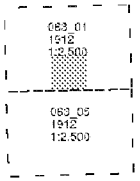
Sussex

Published 1912

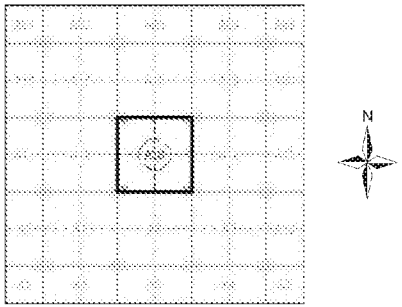
Source map scale - 1:2,500

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Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

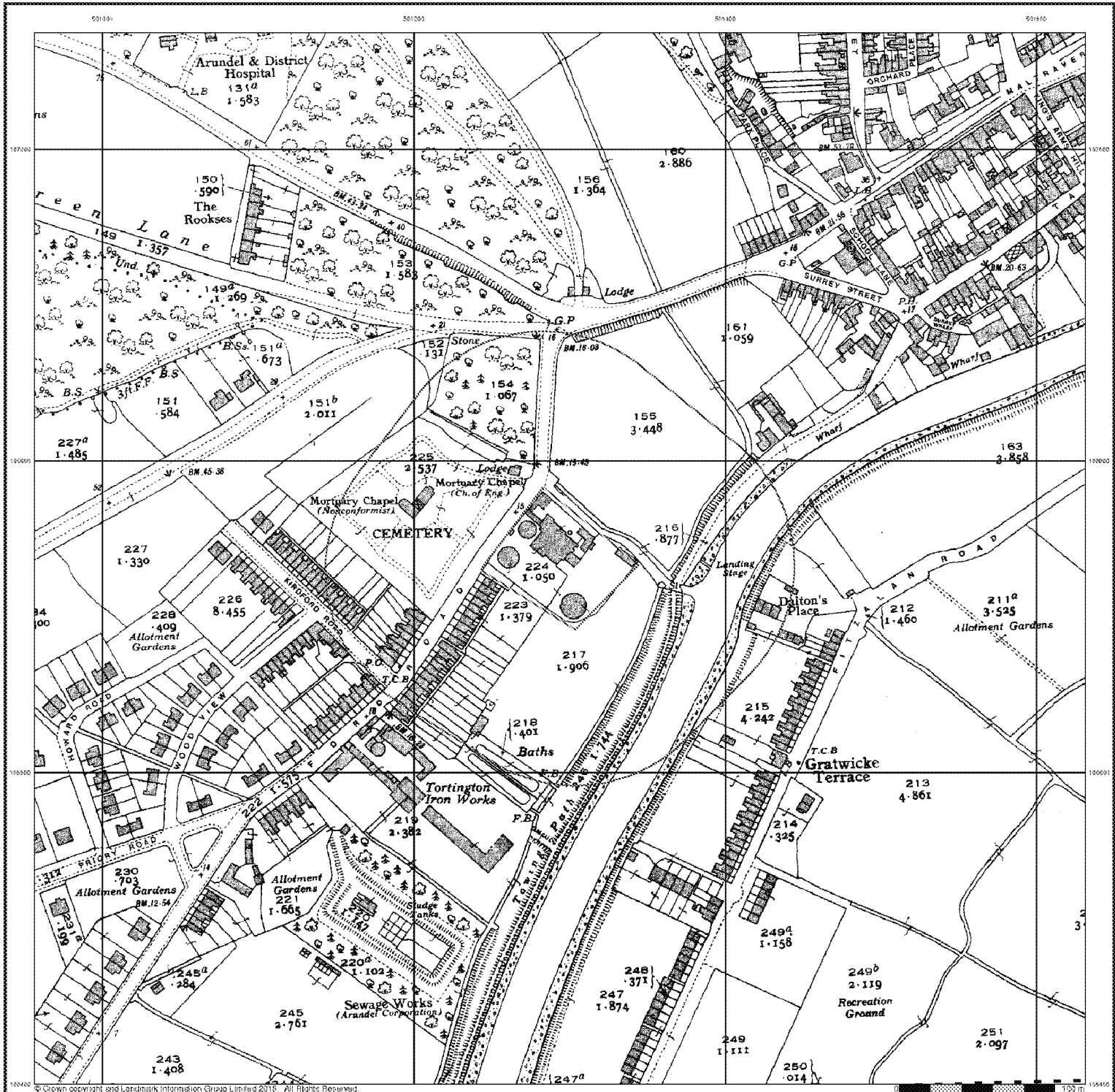
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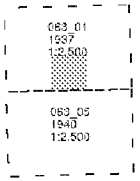
Sussex

Published 1937 - 1940

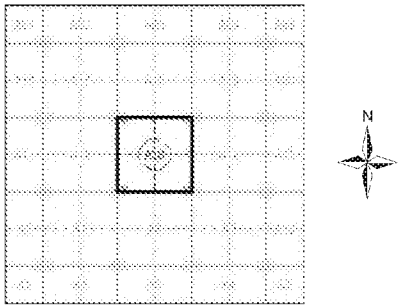
Source map scale - 1:2,500

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Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

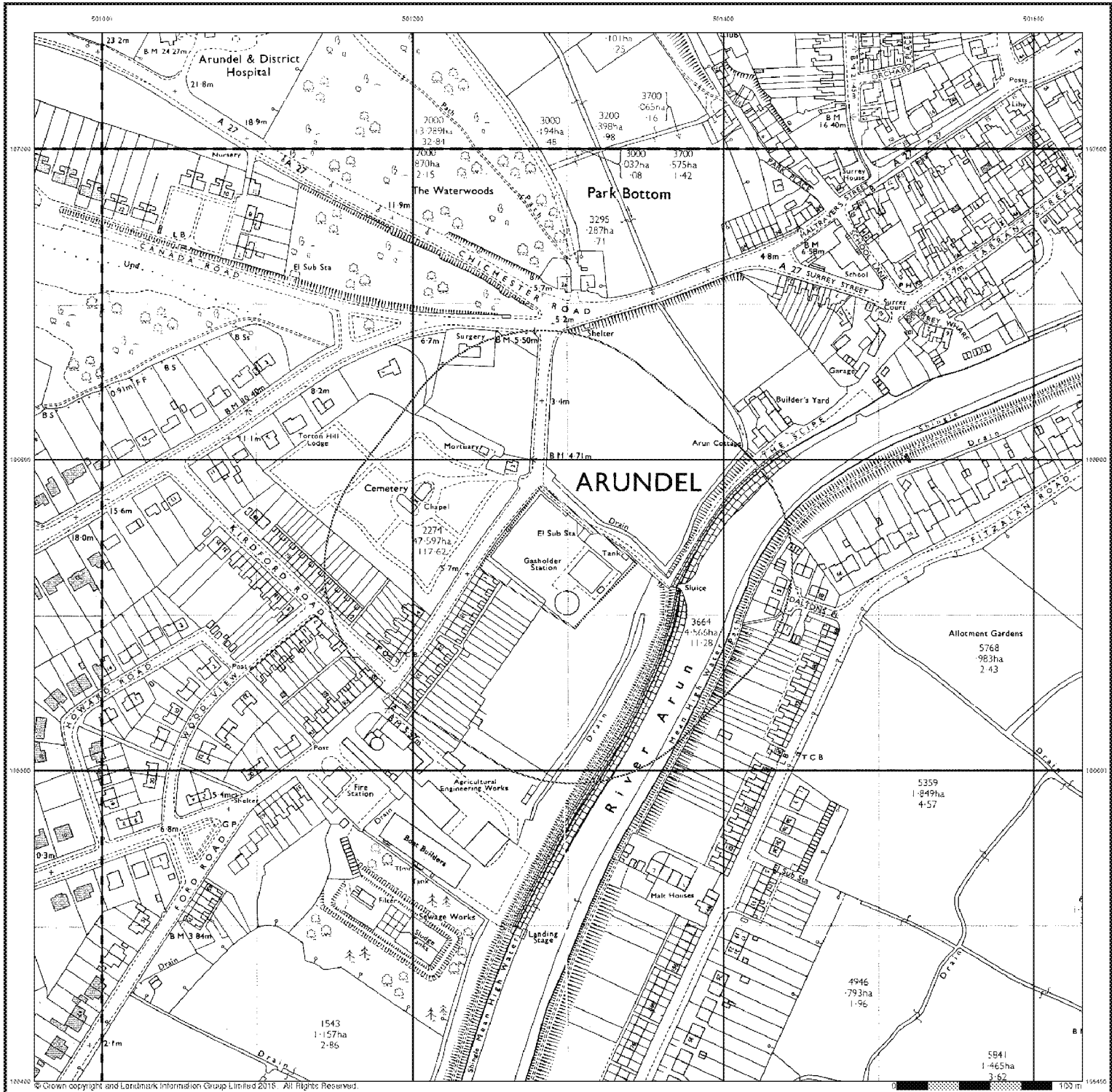
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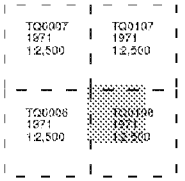
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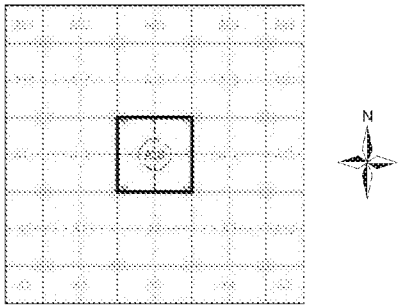
Ordnance Survey Plan
Published 1971
Source map scale - 1:2,500

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Map Name(s) and Date(s)



Historical Map - Segment A13



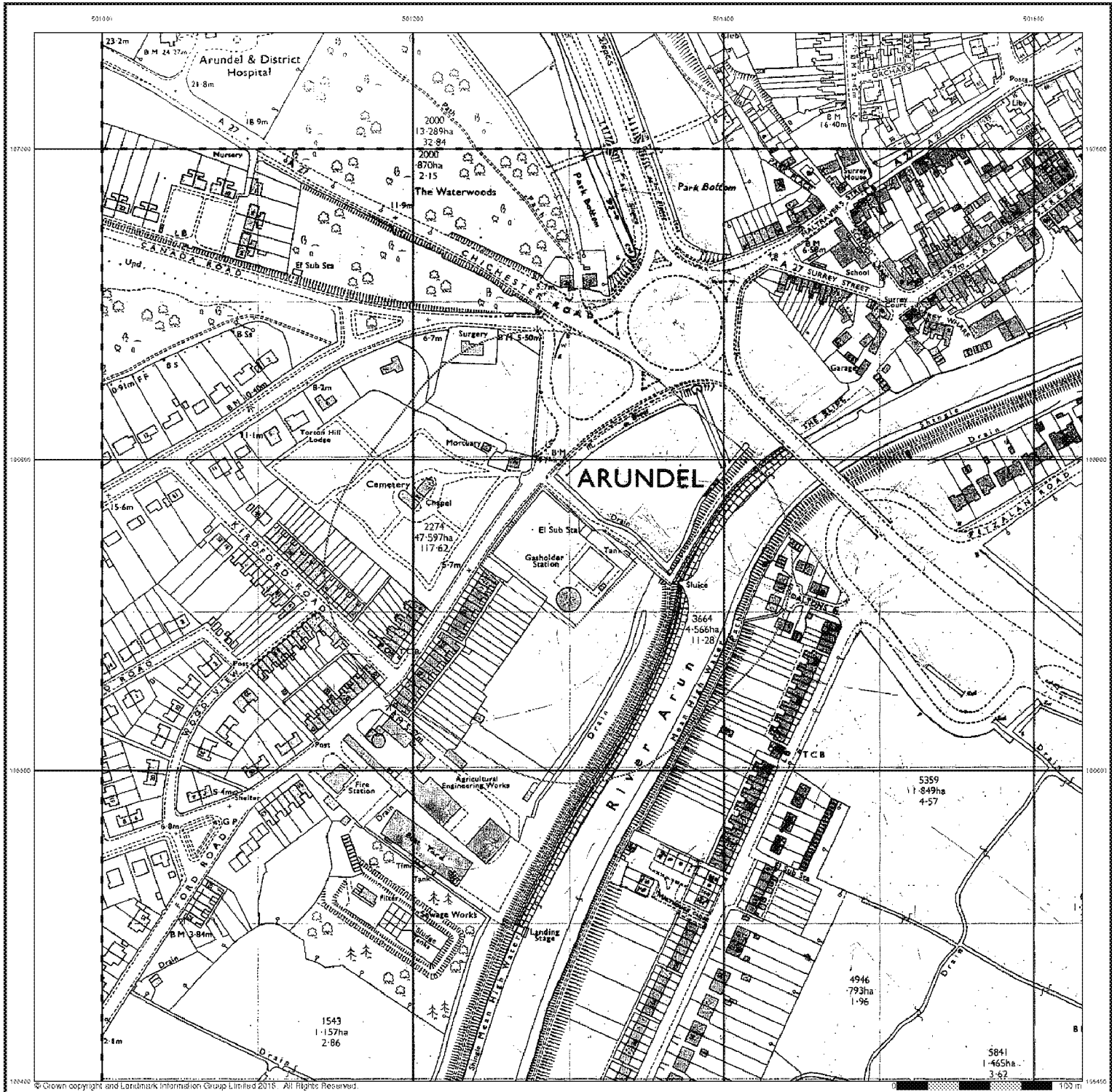
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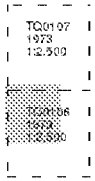
Supply of Unpublished Survey Information

Published 1973

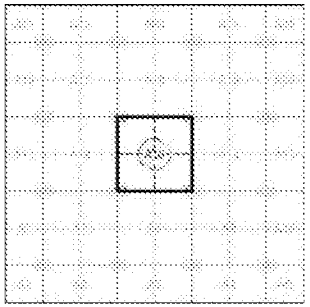
Source map scale - 1:2,500

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

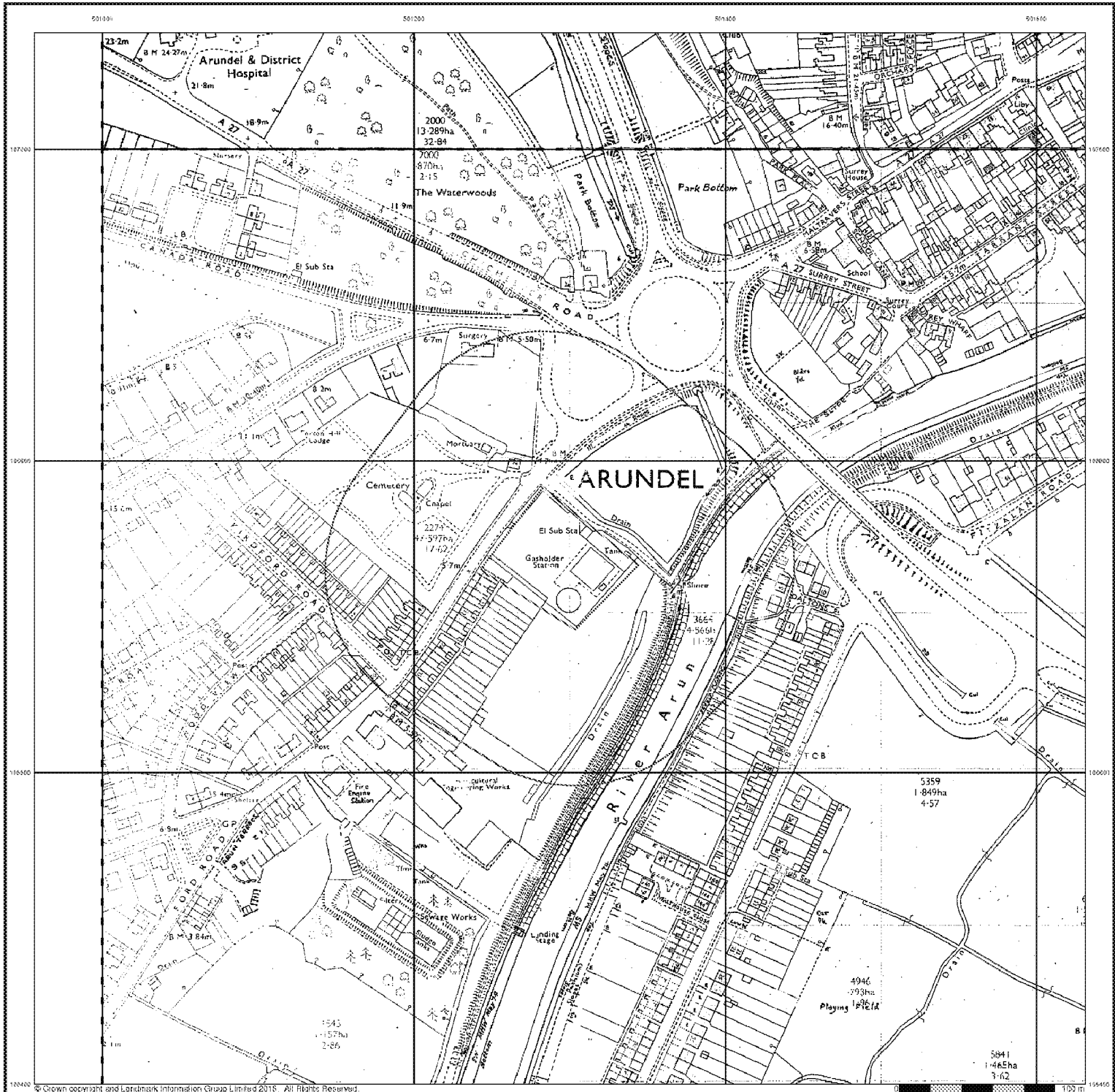
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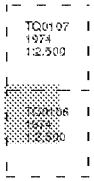
Supply of Unpublished Survey Information

Published 1974

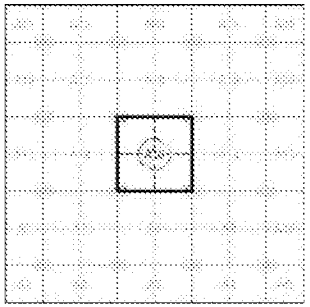
Source map scale - 1:2,500

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Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

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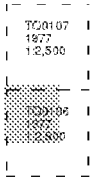
Additional SIMs

Published 1977

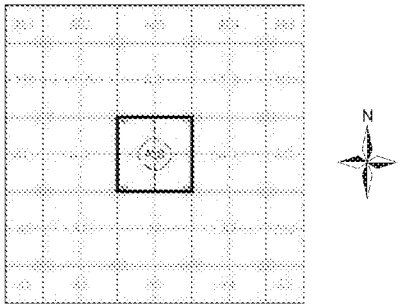
Source map scale - 1:2,500

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

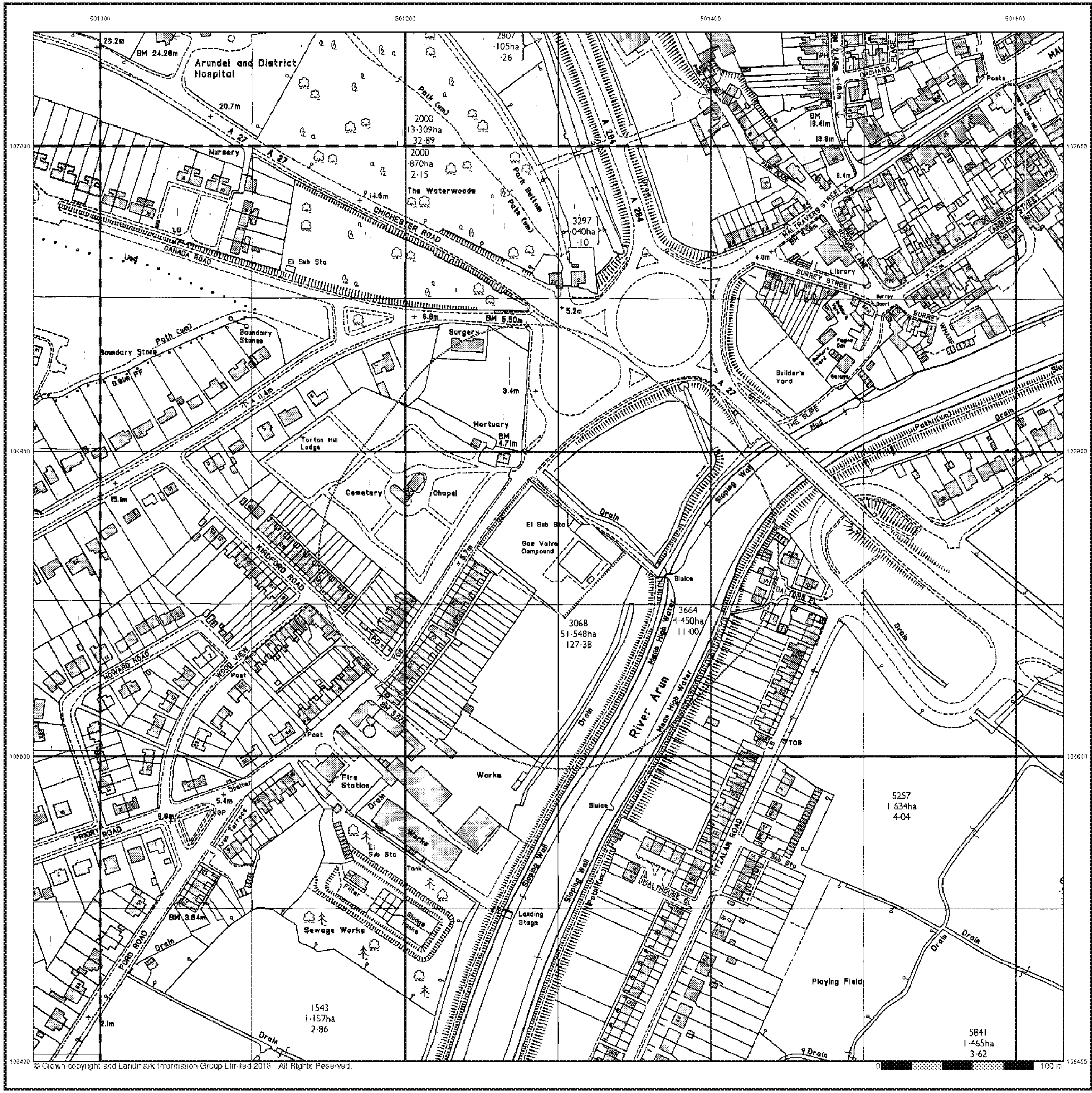
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Ordnance Survey Plan

Published 1979 - 1980

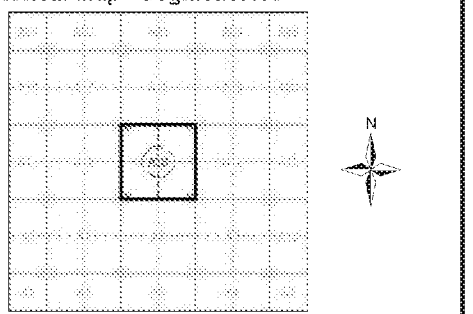
Source map scale - 1:2,500

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Map Name(s) and Date(s)

TQ0007 1979 1:2,500	TQ0107 1979 1:2,500
TQ0006 1980 1:2,500	TQ0106 1980 1:2,500

Historical Map - Segment A13



Order Details

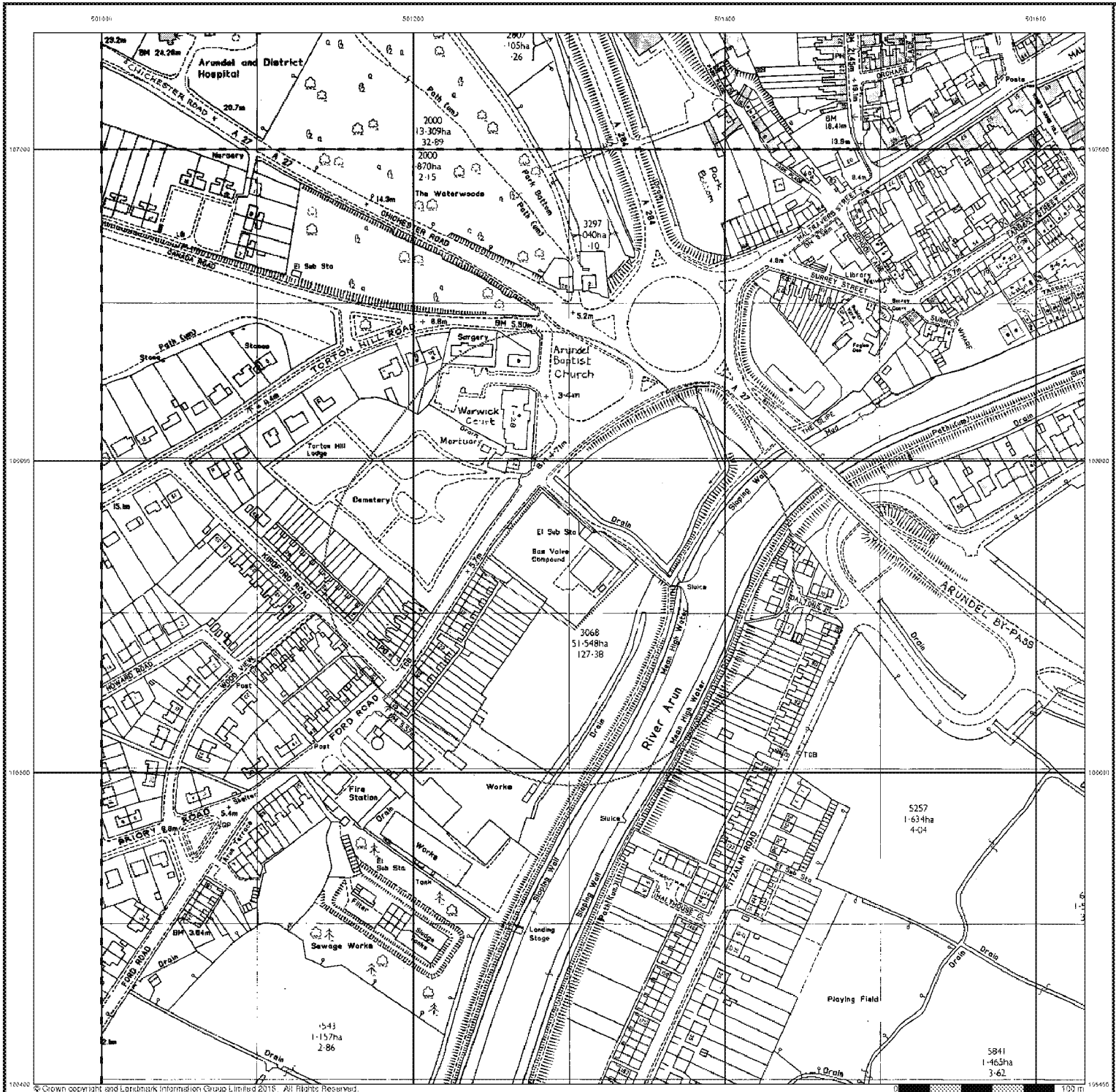
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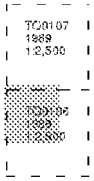
Additional SIMs

Published 1988 - 1989

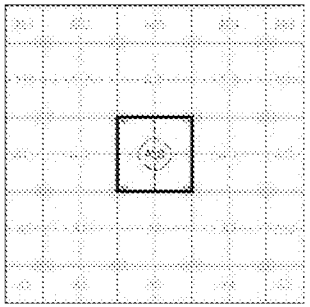
Source map scale - 1:2,500

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Map Name(s) and Date(s)



Historical Map - Segment A13



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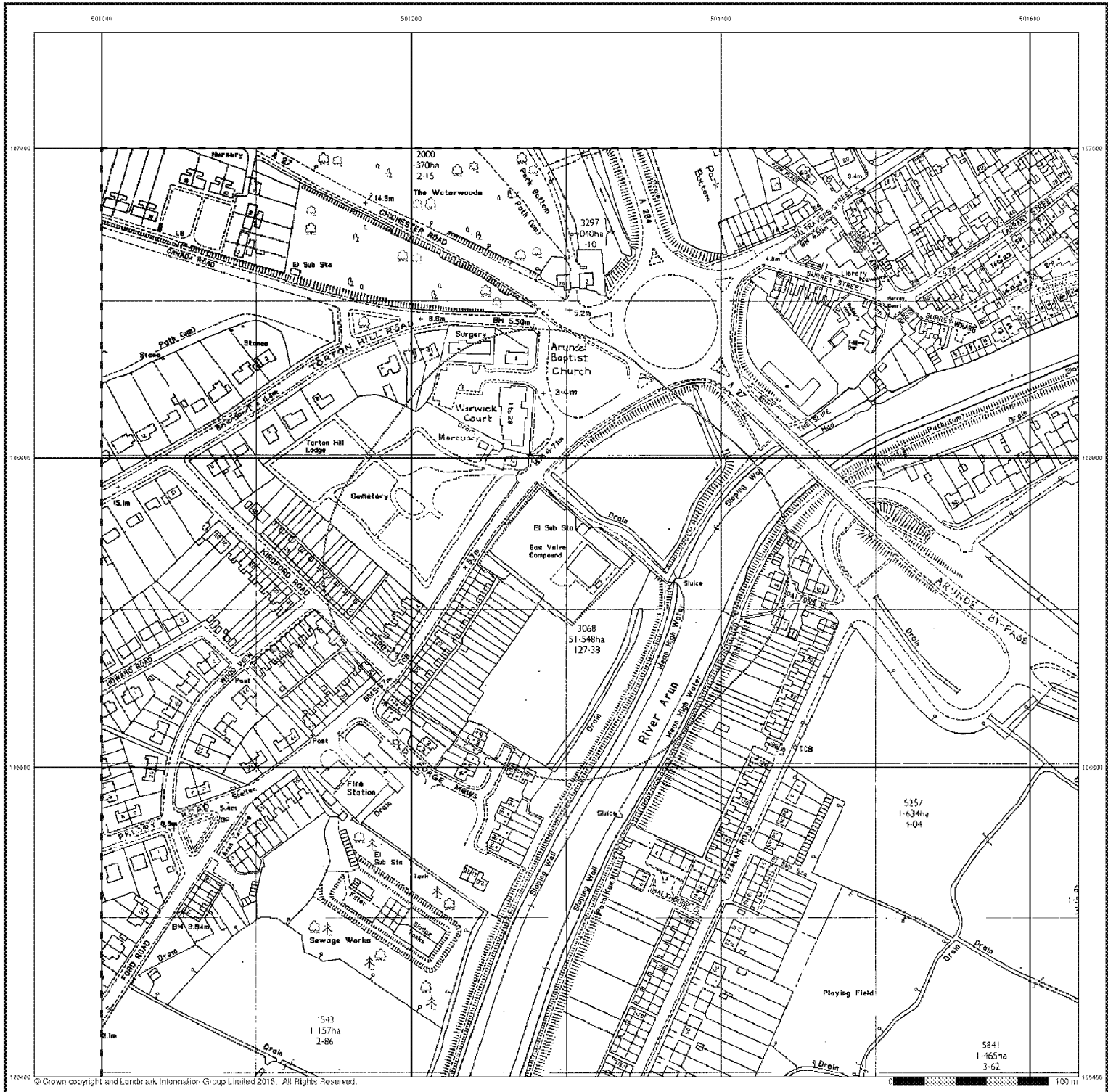
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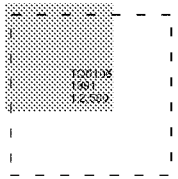
Additional SIMs

Published 1991

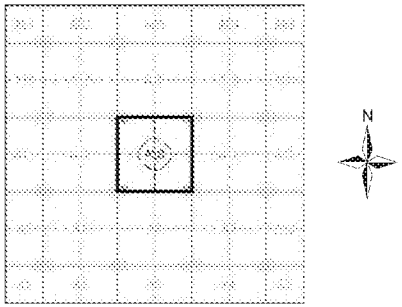
Source map scale - 1:2,500

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Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

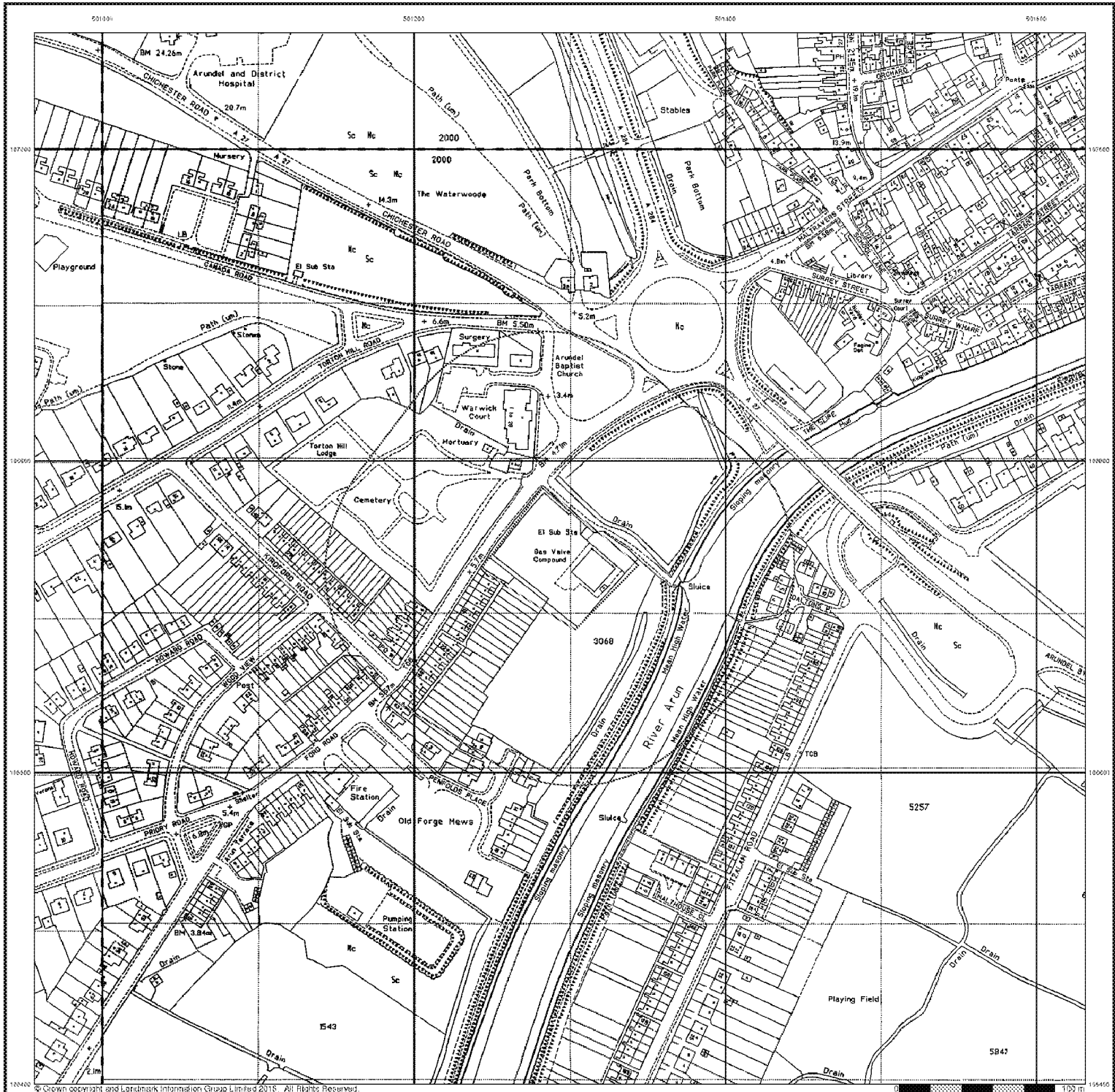
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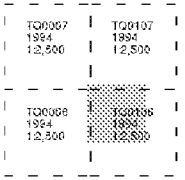
Large-Scale National Grid Data

Published 1994

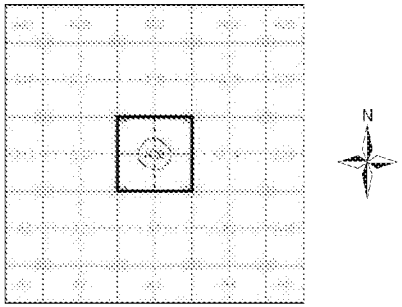
Source map scale - 1:2,500

'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)



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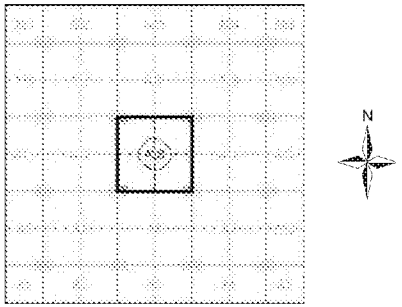
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Historical Aerial Photography

Published 1999

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

Historical Aerial Photography - Segment A13



Order Details

Order Number:	158393817_1_1
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Slice:	A
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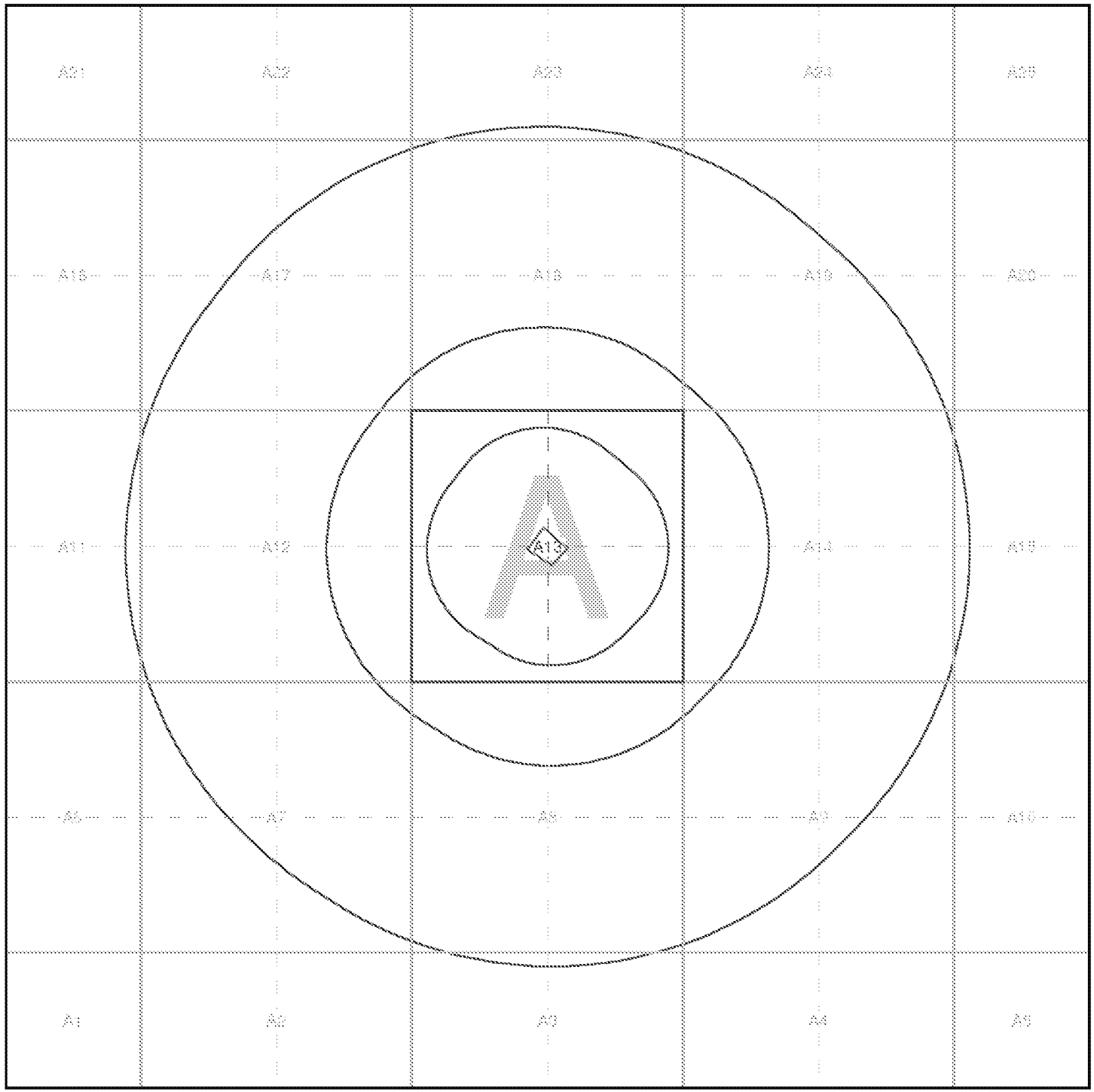
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Index Map

For ease of identification, your site and buffer have been split into Slices, Segments and Quadrants. These are illustrated on the Index Map opposite and explained further below.

Slice
Each slice represents a 1:10,000 plot area (2.7km x 2.7km) for your site and buffer. A large site and buffer may be made up of several slices (represented by a red outline), that are referenced by letters of the alphabet, starting from the bottom left corner of the slice "grid". This grid does not relate to National Grid lines but is designed to give best fit over the site and buffer.

Segment
A segment represents a 1:2,500 plot area. Segments that have plot files associated with them are shown in dark green, others in light blue. These are numbered from the bottom left hand corner within each slice.

Quadrant
A quadrant is a quarter of a segment. These are labelled as NW, NE, SW, SE and are referenced in the datasheet to allow features to be quickly located on plots. Therefore a feature that has a quadrant reference of A7NW will be in Slice A, Segment 7 and the NW Quadrant.

A selection of organisations who provide data within this report:

Map data | British Geological Survey | Environment Agency | ENGLAND

Envirocheck reports are compiled from 136 different sources of data.

Client Details

Mr C Larkin, RSK Environment Ltd, 18 Frogmore Road, Hemel Hempstead, Herts, HP3 9RT

Order Details

Order Number:	158393817_1_1
Customer Ref:	29780
National Grid Reference:	501290, 106740
Site Area (Ha):	0.47
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APPENDIX F
HUMAN HEALTH GENERIC ASSESSMENT CRITERIA

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Generic assessment criteria for human health: residential scenario without home-grown produce

Background

RSK's generic assessment criteria (GAC) were initially prepared following the publication by the Environment Agency (EA) of soil guideline value (SGV) and toxicological (TOX) reports, and associated publications in 2009[1]. RSK GAC were updated following the publication of GAC by LQM/CIEH in 2009[2]. RSK GAC are periodically revised when updated information on toxicological, land use or receptor parameters is published.

Updates to the RSK GAC

In 2014, the publication of Category 4 Screening Levels (C4SL)[3,4], as part of the Defra-funded research project SP1010, included modifications to certain exposure assumptions documented within EA Science Report SC050221/SR3 (herein after referred to as SR3)[5] used in the generation of SGVs.

C4SL were published for six substances (cadmium, arsenic, benzene, benzo(a)pyrene, chromium VI and lead) for a sandy loam soil type with 6% soil organic matter, based on a low level of toxicological concern (LLTC; see Section 2.3 of research project report SP1010[3]). Where a C4SL has been published, the RSK GAC duplicates the C4SL published values using all input parameters within the SP1010 final project report[3] and associated appendices[6], and adopts them as GAC for these six substances.

For all other substances the C4SL exposure modifications relevant for residential without home-grown produce end use have been applied to the current RSK GAC. These include alterations to daily inhalation rates for residential and commercial scenarios, reducing soil adherence factors in children (age classes 1 to 12 only) and reducing exposure frequency for dermal contact outdoors.

The RSK GAC have also been revised with updated toxicology published by LQM/CIEH in 2015[7] or by the USEPA[14], where a C4SL has not been published.

RSK GAC derivation for metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated using the Contaminated Land Exposure Assessment (CLEA) tool v1.071, supporting EA guidance[5,8,9] and revised exposure scenarios published for the C4SL[3]. The SAC are also termed GAC.

Conceptual model

In accordance with SR3[5], the residential without home-grown produce scenario considers risks to a female child between the ages of 0 and 6 years old as the highest risk scenario. In accordance with Box 3.1 of SR3[5], the pathways considered for production of the SAC in the residential without home-grown produce scenario are

- direct soil and dust ingestion in areas of soft landscaping
- dermal contact with soil and indoor dust

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- inhalation of indoor and outdoor dust and vapours.

Figure 1 is a conceptual model illustrating these linkages.

In line with guidance in the EA SGV report for cadmium[1], the RSK GAC for cadmium has been derived based on estimates representative of lifetime exposure. Although young children are generally more likely to have higher exposures to soil contaminants, the renal toxicity of cadmium, and the derivation of the TDI_{oral} and TDI_{inh}, are based on considerations of the kidney burden accumulated over 50 years or so. It is therefore reasonable to consider exposure not just in childhood but averaged over a longer period.

With respect to volatilisation, the CLEA model assumes a simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[9]. The upper boundaries of this partitioning are represented by the maximum aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA model estimates saturated soil concentrations where these limits are reached[9]. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous- or vapour-based soil saturation limits. Model output cells are flagged red where the saturated soil concentration has been exceeded and the contribution of the indoor and outdoor vapour pathway to total exposure is greater than 10%. In this case, further consideration of the following is required[9]:

- Free phase contamination may be present.
- Exposure from the vapour pathways will be over-predicted by the model, as in reality the vapour phase concentration will not increase at concentrations above saturation limits
- Where the vapour pathway contribution is greater than 90%, it is unlikely the relevant health criteria value (HCV) will be exceeded at soil concentrations at least a factor of ten higher than the relevant HCV.

Where the vapour pathway is the predominant pathway (contributes greater than 90% of exposure) or the only exposure route considered and the cell is highlighted red (SAC exceeds saturation limit), the risk based on the assumed conceptual model is likely to be negligible as the vapour risk is assumed to be tolerable at maximum possible soil concentrations. In such circumstances, the vapour pathway exposure should be considered based on the presence of free phase or non-aqueous phase liquid sources and the measured concentrations of volatile organic compounds (VOC) in the vapour phase. Screening could be considered based on setting the SAC as the modelled soil saturation limits. However, as stated within the CLEA handbook[9], this is likely to not be practical in many cases because of the very low saturation limits and, in any case, is highly conservative.

It should also be noted that for mixtures of compounds, free phase may be present where soil (or groundwater) concentrations are well below saturation limits for individual compounds.

Where the vapour pathway is only one of the exposure pathways considered, an additional approach can then be utilised as detailed within Section 4.12 of the CLEA model handbook[9], which explains how to calculate an effective assessment criterion manually.

SR3[5] states that, as a general rule of thumb, it is recognised that estimating vapour phase concentrations from dissolved and sorbed phase contamination by petroleum hydrocarbons are at least a factor of ten higher than those likely to be measured on-site. RSK has therefore applied an empirical subsurface to indoor air correction factor of 10 into the CLEA model chemical database for all petroleum hydrocarbon fractions (including BTEX, trimethylbenzenes and the

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polycyclic aromatic hydrocarbons (PAH) naphthalene, acenaphthene and acenaphthylene) to reduce this conservatism.

Input selection

The most up-to-date published chemical and toxicological data was obtained from EA Report SC050021/SR7[10], the EA TOX[1] reports, the C4SL SP1010 project report and associated appendices[3,6], the 2015 LQM/CIEH report[7] or the USEPA IRIS database[14]. Where a C4SL has been published, the RSK GAC have duplicated the C4SL published values using all input parameters within the SP1010 final project report[3] and associated appendices[6], and has adopted them as GAC for these six substances. Toxicological and specific chemical parameters for 1,2,4-trimethylbenzene and methyl tertiary-butyl ether (MTBE) were obtained from the CL:AIRE Soil Generic Assessment Criteria report[11].

For TPH, aromatic hydrocarbons C_5–C_8 were not modelled, as this range comprises benzene (>EC5-EC7) and toluene (>EC7-EC8), which are modelled separately.

Physical parameters

For the residential without home-grown produce scenario, the CLEA default building is a small, two-storey terrace house with a concrete ground-bearing slab. SR3[5] notes this residential building type to be the most conservative in terms of potential for vapour intrusion. The building parameters used in the production of the RSK GACs are the default CLEA v1.06 inputs presented in Table 3.3 of SR3[3], with a dust loading factor detailed in Section 9.3 of SR3[5]. The parameters for a sandy loam soil type were used in line with Table 4.4 of SR3[5]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this SOM, RSK has produced an additional set of GAC for SOM of 1% and 2.5% for all substances using the CLEA tool.

Summary of modifications to the default CLEA SR3[5] input parameters for residential without home-grown produce

In summary, the RSK GAC were produced using the default input parameters for soil properties, the air dispersion model, building properties and the vapour model detailed in SR3[5]. Modifications to the default SR3[5] exposure scenarios based on the C4SL exposure scenarios[3] are presented in Table 2 below.

The final selected GAC are presented by pathway in Table 3 and the combined GAC in Table 4.

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Figure 1: Conceptual model for CLEA residential scenario without home-grown produce

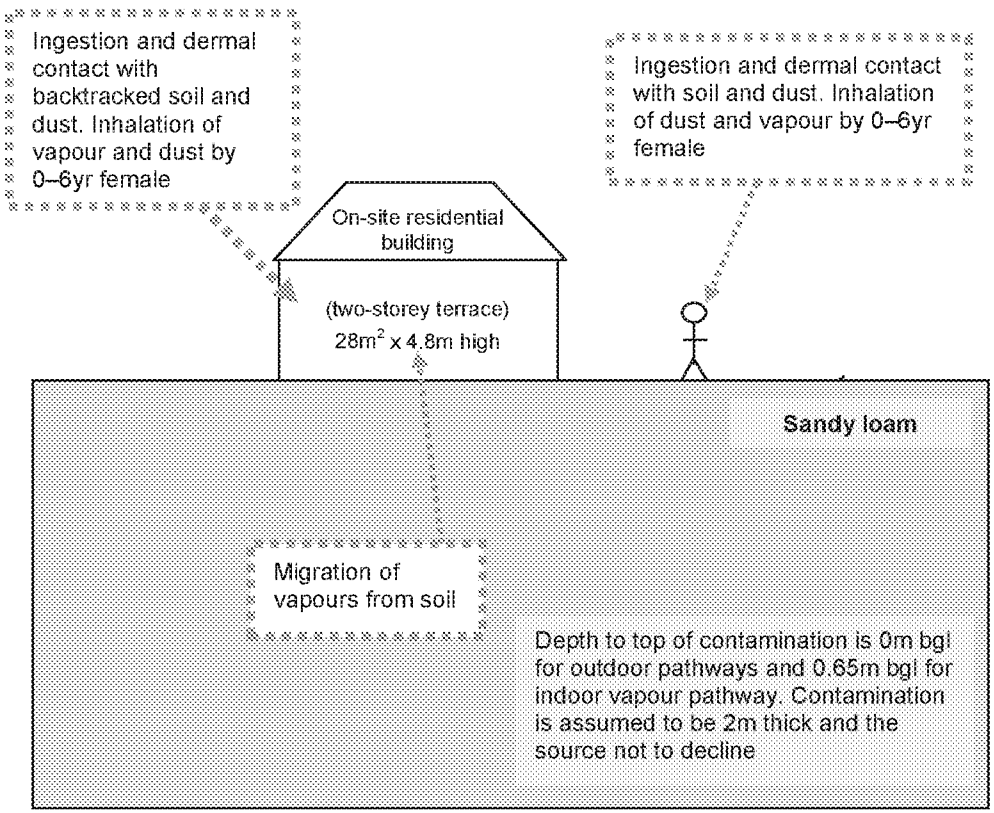


Table 1: Exposure assessment parameters for residential scenario without home-grown produce – inputs for CLEA model

Parameter	Value	Justification
Land use	Residential without home-grown produce	Chosen land use
Receptor	Female child	Key generic assumption given in Box 3.1, SR3[5]
Building	Small terraced house	Key generic assumption given in Box 3.1, SR3[5]. Small, two-storey terraced house chosen, as it is the most conservative residential building type in terms of protection from vapor intrusion (Section 3.4.6, SR3)[5]
Soil type	Sandy loam	Most common UK soil type (Section 4.3.1, from Table 3.1, SR3)[5]
Start age class (AC)	1	Range of age classes corresponding to key generic assumption that the critical receptor is a young female child aged 0–6. From Box 3.1, SR3[5]
End AC	6	
SOM (%)	6	Representative of sandy loamy soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[13]
	1	To provide SAC for sites where SOM <6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Residential without home-grown produce – modified receptor data

Parameter	Unit	Age class					
		1	2	3	4	5	6
Soil to skin adherence factor – (outdoor)	mg soil/cm^2 skin	0.1	0.1	0.1	0.1	0.1	0.1
Justification		Table 3.5, SP1010[3]					
Inhalation rate	m^3 day^{-1}	5.4	8.0	8.9	10.1	10.1	10.1
Justification		Mean value USEPA, 2011[12]; Table 3.2, SP1010[3]					
Notes: For **cadmium**, the exposure assessment for a residential land use is based on estimates representative of lifetime exposure AC1-18. This is because the TDI_{oral} and TDI_{inh} are based on considerations of the kidney burden accumulated over 50 years. It is therefore reasonable to consider exposure not just in childhood but averaged over a longer period. See the Environment Agency Science Report SC05002/ TOX 3[1], Science Report SC050021/Cadmium SGV[1] and the project report SP1010[3] for more information.							

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GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITHOUT HOME-GROWN PRODUCE

Table 3

Human Health Generic Assessment Criteria by Pathway for Residential Scenario Without Home-Grown Produce

Compound	Notes	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
		Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Metals													
Arsenic	(a,b)	3.99E+01	5.26E+02	NR	NR	3.99E+01	5.26E+02	NR	NR	3.99E+01	5.26E+02	NR	NR
Cadmium	(a)	1.95E+02	4.88E+02	1.48E+02	NR	1.95E+02	4.88E+02	1.48E+02	NR	1.95E+02	4.88E+02	1.48E+02	NR
Chromium (III) - trivalent	(c)	1.99E+04	9.07E+02	NR	NR	1.99E+04	9.07E+02	NR	NR	1.99E+04	9.07E+02	NR	NR
Chromium (VI) - hexavalent	(a,d)	5.91E+01	2.06E+01	NR	NR	5.91E+01	2.06E+01	NR	NR	5.91E+01	2.06E+01	NR	NR
Copper		1.09E+04	1.41E+04	7.13E+03	NR	1.09E+04	1.41E+04	7.13E+03	NR	1.09E+04	1.41E+04	7.13E+03	NR
Lead	(a)	3.14E+02	NR	NR	NR	3.14E+02	NR	NR	NR	3.14E+02	NR	NR	NR
Elemental Mercury (Hg^0)	(d)	NR	2.41E+01	NR	4.31E+00	NR	5.74E+01	NR	1.07E+01	NR	1.29E+02	NR	2.58E+01
Inorganic Mercury (Hg^{2+})		5.71E+01	3.82E+02	5.22E+01	NR	5.71E+01	4.04E+02	5.68E+01	NR	5.71E+01	2.63E+02	5.68E+01	NR
Methyl Mercury (Hg^{1+})		8.05E+01	1.67E+01	9.16E+00	7.33E+01	1.90E+01	4.82E+01	1.90E+01	1.42E+02	1.90E+01	7.88E+01	1.46E+01	3.04E+02
Nickel	(d)	1.98E+02	1.81E+02	NR	NR	1.98E+02	1.81E+02	NR	NR	1.98E+02	1.81E+02	NR	NR
Selenium	(b)	4.31E+02	NR	NR	NR	4.31E+02	NR	NR	NR	4.31E+02	NR	NR	NR
Zinc	(b)	4.06E+04	3.63E+07	NR	NR	4.06E+04	3.63E+07	NR	NR	4.06E+04	3.63E+07	NR	NR
Cyanide (free)		4.03E+01	1.37E+04	4.02E+01	NR	4.03E+01	1.37E+04	4.02E+01	NR	4.03E+01	1.37E+04	4.02E+01	NR
Volatile Organic Compounds													
Benzene	(a)	7.36E+01	8.01E+01	6.50E+01	1.22E+03	7.36E+01	1.82E+00	1.64E+00	2.26E+03	7.36E+01	3.48E+01	3.32E+00	4.71E+03
Toluene		2.87E+04	9.08E+02	8.60E+02	8.69E+02	2.87E+04	2.00E+03	1.87E+03	1.92E+03	2.87E+04	4.55E+03	3.93E+03	4.36E+03
Ethylbenzene		1.29E+04	8.34E+01	8.19E+01	5.18E+02	1.29E+04	1.96E+02	1.93E+02	1.22E+03	1.29E+04	4.58E+02	4.49E+02	2.84E+03
Xylene - m		2.32E+04	8.72E+01	8.22E+01	6.25E+02	2.32E+04	1.95E+02	1.83E+02	1.47E+03	2.32E+04	4.56E+02	4.47E+02	3.46E+03
Xylene - o		2.32E+04	8.87E+01	8.63E+01	4.78E+02	2.32E+04	2.08E+02	2.06E+02	1.12E+03	2.32E+04	4.86E+02	4.76E+02	2.62E+03
Xylene - p		2.32E+04	7.83E+01	7.90E+01	5.76E+02	2.32E+04	1.86E+02	1.85E+02	1.35E+03	2.32E+04	4.36E+02	4.28E+02	3.17E+03
Total xylene		2.32E+04	7.83E+01	7.90E+01	6.25E+02	2.32E+04	1.86E+02	1.85E+02	1.47E+03	2.32E+04	4.36E+02	4.28E+02	3.46E+03
Methyl tertiary-Butyl ether (MTBE)		3.87E+04	1.04E+02	1.04E+02	2.04E+04	3.87E+04	1.60E+02	1.60E+02	3.31E+04	3.87E+04	3.21E+02	3.19E+02	6.27E+04
Trichloroethene		6.45E+01	1.72E+02	1.72E+02	1.54E+03	6.45E+01	2.59E+02	2.59E+02	3.22E+03	6.45E+01	7.98E+02	7.97E+02	7.14E+03
Tetrachloroethene		7.13E+02	1.79E+01	1.79E+01	4.24E+02	7.13E+02	4.02E+01	4.02E+01	9.51E+02	7.13E+02	9.21E+01	9.20E+01	2.18E+03
1,1,1-Trichloroethane		7.74E+04	9.01E+00	8.93E+00	1.43E+03	7.74E+04	1.84E+01	1.84E+01	2.92E+03	7.74E+04	4.04E+01	4.04E+01	6.39E+03
1,1,1,2-Tetrachloroethane		7.34E+02	1.64E+00	1.53E+00	2.60E+03	7.34E+02	3.66E+00	3.55E+00	6.02E+03	7.34E+02	8.28E+00	8.20E+00	1.40E+04
1,1,2,2-Tetrachloroethane		7.34E+00	3.92E+01	3.80E+00	2.67E+03	7.34E+00	8.04E+00	7.96E+00	5.46E+03	7.34E+02	1.78E+01	1.73E+01	1.20E+04
Carbon Tetrachloride		5.15E+02	2.58E+02	2.58E+02	1.52E+03	5.15E+02	5.65E+02	3.64E+02	3.32E+03	5.15E+02	1.28E+01	1.28E+01	7.54E+03
1,2-Dichloroethane		1.35E+01	9.20E+01	8.27E+00	3.41E+03	1.35E+01	1.33E+02	1.33E+02	4.91E+03	1.35E+01	2.88E+02	2.87E+02	8.43E+03
Vinyl Chloride		1.81E+00	7.7E+04	7.73E+04	1.36E+03	1.81E+00	1.00E+03	3.98E+04	1.76E+03	1.81E+00	1.33E+03	1.33E+03	2.69E+03
1,2,4-Trimethylbenzene		NR	5.56E+00	NR	4.74E+02	NR	1.29E+01	NR	1.16E+03	NR	3.88E+01	NR	2.76E+03
1,3,5-Trimethylbenzene	(e)	NR	NR	NR	2.30E+02	NR	NR	NR	5.52E+02	NR	NR	NR	1.30E+03
Semi-Volatile Organic Compounds													
Acenaphthene		7.64E+03	4.86E+04	6.60E+03	5.70E+01	7.64E+03	1.18E+05	7.17E+03	1.41E+02	7.64E+03	2.58E+05	7.43E+03	3.36E+02
Acenaphthylene		7.65E+03	4.59E+04	6.55E+03	8.61E+01	7.65E+03	1.11E+05	7.15E+03	2.12E+02	7.65E+03	2.53E+05	7.42E+03	5.06E+02
Anthracene		3.82E+04	1.53E+05	3.06E+04	1.17E+00	3.82E+04	3.77E+05	3.47E+04	2.91E+00	3.82E+04	8.76E+05	3.66E+04	6.96E+00
Benzo(a)anthracene		1.98E+01	2.47E+01	1.10E+01	1.71E+00	1.98E+01	4.37E+01	1.36E+01	4.28E+00	1.98E+01	6.28E+01	1.50E+01	1.03E+01
Benzo(a)pyrene	(a)	5.34E+00	3.51E+01	NR	9.11E-01	5.34E+00	3.77E+01	NR	2.28E+00	5.34E+00	3.89E+01	NR	5.46E+00
Benzo(b)fluoranthene		4.97E+00	1.93E+01	3.65E+00	1.22E+00	4.97E+00	2.13E+01	4.03E+00	3.04E+00	4.97E+00	2.22E+01	4.06E+00	7.29E+00
Benzo(g,h,i)perylene		4.38E+02	1.87E+03	3.55E+02	1.54E-02	4.38E+02	1.94E+03	3.58E+02	3.85E-02	4.38E+02	1.97E+03	3.59E+02	9.23E-02
Benzo(k)fluoranthene		1.31E+02	5.41E+02	1.05E+02	6.87E-01	1.31E+02	5.76E+02	1.07E+02	1.72E+00	1.31E+02	5.91E+02	1.07E+02	4.12E+00
Chrysene		3.95E+01	1.19E+02	2.87E+01	4.40E-01	3.95E+01	1.49E+02	3.12E+01	1.10E+00	3.95E+01	1.66E+02	3.13E+01	2.64E+00
Dibenzo(a,h)anthracene		3.95E-01	1.45E+00	3.10E-01	3.93E-03	3.95E-01	1.64E+00	3.18E-01	9.82E-03	3.95E-01	1.74E+00	3.22E-01	2.36E-02
Fluoranthene		1.59E+03	3.83E+04	1.55E+03	1.89E+01	1.59E+03	8.67E+04	1.56E+03	4.73E+01	1.59E+03	1.85E+05	1.56E+03	1.13E+02
Fluorene		5.09E+03	6.20E+03	2.80E+03	3.09E+01	5.09E+03	1.53E+04	3.82E+03	7.65E+01	5.09E+03	3.62E+04	4.47E+03	1.83E+02
Indeno(1,2,3-cd)pyrene		5.65E-01	2.12E+02	4.46E-01	6.13E-02	5.65E-01	2.38E+02	4.56E-01	1.53E-01	5.65E-01	2.50E+02	4.60E-01	3.68E-01

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITHOUT HOME-GROWN PRODUCE

Table 3

Human Health Generic Assessment Criteria by Pathway for Residential Scenario Without Home-Grown Produce

Compound	Notes	SAC Appropriate to Pathway SOM 1% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 2.5% (mg/kg)			Soil Saturation Limit (mg/kg)	SAC Appropriate to Pathway SOM 6% (mg/kg)			Soil Saturation Limit (mg/kg)
		Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Naphthalene		2.50E+03	2.39E+01	2.31E+01	7.64E+01	2.50E+03	5.58E+01	5.48E+01	1.83E+02	2.50E+03	1.31E+02	1.29E+02	4.32E+02
Phenanthrene		1.58E+03	7.17E+03	1.30E+03	3.60E+01	1.58E+03	1.76E+04	1.45E+03	8.96E+01	1.58E+03	4.07E+04	1.62E+03	2.14E+02
Pyrene		3.82E+03	8.79E+04	3.66E+03	2.20E+00	3.82E+03	2.04E+05	3.75E+03	5.49E+00	3.62E+03	4.23E+05	3.79E+03	1.32E+01
Phenol		6.48E+04	4.58E+03	4.35E+03	2.42E+04	6.48E+04	6.95E+03	6.68E+03	3.81E+04	6.48E+04	1.39E+04	1.17E+04	7.03E+04
Total Petroleum Hydrocarbons													
Aliphatic hydrocarbons EC_5-EC_6		3.23E+05	4.23E+01	4.23E+01	3.04E+02	3.23E+05	7.79E+01	7.79E+01	5.58E+02	3.23E+05	1.81E+02	1.81E+02	1.15E+03
Aliphatic hydrocarbons >EC_6-EC_8		3.23E+05	1.04E+02	1.04E+02	1.44E+02	3.23E+05	4.31E+02	4.31E+02	3.22E+02	3.23E+05	5.29E+02	5.29E+02	7.36E+02
Aliphatic hydrocarbons >EC_8-EC_{10}		6.45E+03	2.68E+01	2.68E+01	7.77E+01	6.45E+03	6.56E+01	6.52E+01	1.90E+02	6.45E+03	1.58E+02	1.58E+02	4.51E+02
Aliphatic hydrocarbons >EC_{10}-EC_{12}		6.45E+03	1.33E+02	1.32E+02	4.75E+01	6.45E+03	3.31E+02	3.27E+02	1.18E+02	6.45E+03	7.93E+02	7.67E+02	2.83E+02
Aliphatic hydrocarbons >EC_{12}-EC_{16}		6.45E+03	1.11E+03	1.06E+03	2.37E+01	6.45E+03	2.78E+03	2.42E+03	5.91E+01	6.45E+03	6.67E+03	4.37E+03	1.42E+02
Aliphatic hydrocarbons >EC_{16}-EC_{35}	(b)	6.50E+04	NR	NR	8.48E+00	9.25E+04	NR	NR	2.12E+01	1.11E+05	NR	NR	5.09E+01
Aliphatic hydrocarbons >EC_{35}-EC_{44}	(b)	6.50E+04	NR	NR	8.48E+00	9.25E+04	NR	NR	2.12E+01	1.11E+05	NR	NR	5.09E+01
Aromatic hydrocarbons >EC_5-EC_{10}		2.58E+03	4.74E+01	4.72E+01	6.13E+02	2.58E+03	1.16E+02	1.15E+02	1.50E+03	2.58E+03	2.77E+02	2.69E+02	3.58E+03
Aromatic hydrocarbons >EC_{10}-EC_{12}		2.58E+03	2.58E+02	2.52E+02	3.64E+02	2.58E+03	6.49E+02	5.94E+02	8.99E+02	2.58E+03	1.52E+03	1.24E+03	2.15E+03
Aromatic hydrocarbons >EC_{12}-EC_{16}		2.58E+03	2.65E+03	1.80E+03	1.69E+02	2.58E+03	7.07E+03	2.30E+03	4.19E+02	2.58E+03	1.68E+04	2.48E+03	1.00E+03
Aromatic hydrocarbons >EC_{16}-EC_{21}	(b)	1.86E+03	NR	NR	5.37E+01	1.90E+03	NR	NR	1.34E+02	1.92E+03	NR	NR	3.21E+02
Aromatic hydrocarbons >EC_{21}-EC_{35}	(b)	1.93E+03	NR	NR	4.83E+00	1.93E+03	NR	NR	1.21E+01	1.93E+03	NR	NR	2.90E+01
Aromatic hydrocarbons >EC_{35}-EC_{44}	(b)	1.93E+03	NR	NR	4.83E+00	1.93E+03	NR	NR	1.21E+01	1.93E+03	NR	NR	2.90E+01

Notes:

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

Calculated SAC exceeds soil saturation limit and may significantly affect the interpretation of any exceedances as the contribution of the indoor and outdoor vapour pathway to total exposure is >10%.

Calculated SAC exceeds soil saturation limit but the exceedance will not affect the SAC significantly as the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.

Calculated SAC does not exceed the soil saturation limit.

The SAC for organic compounds are dependant upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58. 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, PAHs napthalene, acenaphthene and acenaphthylene, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway (Section 10.1.1, SR3)

(a) SAC for arsenic, benzene, benzo(a)pyrene, cadmium, chromium VI and lead are derived using the C4SL toxicology data.

(b) SAC for selenium should not include the inhalation pathway as no expert group HCV has been derived; aliphatic and aromatic hydrocarbons >EC16 should not include inhalation pathway due to their non-volatile nature and inhalation exposure being minimal (oral, dermal and inhalation exposure is compared to the oral HCV); arsenic should only be based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The Oral SAC should be adopted for zinc and benzo(a)pyrene.

(c) SAC for CrIII should be based on the lower of the oral and inhalation SAC (see LQM/CIEH 2015 Section 6.8)

(d) SAC for elemental mercury, chromium VI and nickel should be based on the inhalation pathway only.

(e) SAC for 1,3,5-trimethylbenzene is not recorded owing to the lack of toxicological data, SAC for 1,2,4 trimethylbenzene may be used.

Table 4
Human health generic assessment criteria for residential without home-grown produce

Compound	SAC for Soil SOM 1% (mg/kg)	SAC for Soil SOM 2.5% (mg/kg)	SAC for Soil SOM 6% (mg/kg)
Metals			
Arsenic	40	40	40
Cadmium	149	149	149
Chromium (III) - trivalent	910	910	910
Chromium (VI) - hexavalent	21	21	21
Copper	7,100	7,100	7,100
Lead	310	310	310
Elemental Mercury (Hg^0)	0.2	0.6	1.2
Inorganic Mercury (Hg^{2+})	56	56	56
Methyl Mercury (Hg^{4+})	9	12	15
Nickel	180	180	180
Selenium	430	430	430
Zinc	40,000	40,000	40,000
Cyanide (free)	40	40	40
Volatile Organic Compounds			
Benzene	0.9	1.6	3.3
Toluene	900 (869)	1,900	3,900
Ethylbenzene	80	190	440
Xylene - m	80	190	450
Xylene - o	90	210	480
Xylene - p	80	180	430
Total xylene	80	180	430
Methyl tertiary-Butyl ether (MTBE)	100	170	320
Trichloroethene	0.02	0.04	0.08
Tetrachloroethene	0.2	0.4	0.9
1,1,1-Trichloroethane	9.0	18.4	40.4
1,1,1,2 Tetrachloroethane	1.5	3.5	8.2
1,1,2,2-Tetrachloroethane	3.9	8.0	17.2
Carbon Tetrachloride	0.026	0.056	0.128
1,2-Dichloroethane	0.009	0.013	0.023
Vinyl Chloride	0.0008	0.0010	0.0015
1,2,4-Trimethylbenzene	5.6	12.9	26.9
1,3,5-Trimethylbenzene	NR	NR	NR
Semi-Volatile Organic Compounds			
Acenaphthene	6,600 (57)	7,200	7,400
Acenaphthylene	6,600 (86)	7,200	7,400
Anthracene	31,000 (1.17)	35,000	37,000
Benzo(a)anthracene	11.0	13.6	15.0
Benzo(a)pyrene	5.3	5.3	5.3
Benzo(b)fluoranthene	4.0	4.0	4.1
Benzo(g,h,i)perylene	355	358	359
Benzo(k)fluoranthene	106	107	107
Chrysene	30	31	32
Dibenzo(a,h)anthracene	0.31	0.32	0.32
Fluoranthene	1,500	1,600	1,600
Fluorene	2,800 (31)	3,800 (77)	4,500 (183)
Indeno(1,2,3-cd)pyrene	45	46	46
Naphthalene	23	55	125
Phenanthrene	1,300 (36)	1,450	1,520
Pyrene	3,700	3,800	3,800
Phenol	440*	688	1,170
Total Petroleum Hydrocarbons			
Aliphatic hydrocarbons EC_5-EC_6	42	78	161
Aliphatic hydrocarbons >EC_6-EC_8	100	230	530
Aliphatic hydrocarbons >EC_8-EC_{10}	27	65	155
Aliphatic hydrocarbons >EC_{10}-EC_{12}	130 (48)	330 (118)	770 (283)
Aliphatic hydrocarbons >EC_{12}-EC_{16}	1,100 (24)	2,400 (59)	4,400 (142)
Aliphatic hydrocarbons >EC_{16}-EC_{35}	65,000 (8)	92,000 (21)	111,000
Aliphatic hydrocarbons >EC_{35}-EC_{44}	65,000 (8)	92,000 (21)	111,000
Aromatic hydrocarbons >EC_8-EC_{10}	47	115	269
Aromatic hydrocarbons >EC_{10}-EC_{12}	300	600	1,200
Aromatic hydrocarbons >EC_{12}-EC_{16}	1,800 (169)	2,300 (419)	2,500
Aromatic hydrocarbons >EC_{16}-EC_{21}	1,900	1,900	1,900
Aromatic hydrocarbons >EC_{21}-EC_{35}	1,900	1,900	1,900
Aromatic hydrocarbons >EC_{35}-EC_{44}	1,900	1,900	1,900
Minerals			
Asbestos	No asbestos detected with ID or <0.001% dry weight[1]		

Notes:

* Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

NR - SAC for 1,3,5-trimethylbenzene is not recorded owing to the lack of toxicological data, SAC for 1,2,4 trimethylbenzene may be used

EC - equivalent carbon. SAC - soil assessment criteria.

[1] LOD for weight of asbestos per unit weight of soil calculated on a dry weight basis using PLM, handpicking and gravimetry.

The SAC for organic compounds are dependent on Soil Organic Matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58.
1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, PAHs naphtalene, acenaphthene and acenaphthylene, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

(VALUE IN BRACKETS)
RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limits given in brackets.

APPENDIX G
GENERIC GROUNDWATER ASSESSMENT CRITERIA (GRAC) FOR HUMAN HEALTH:

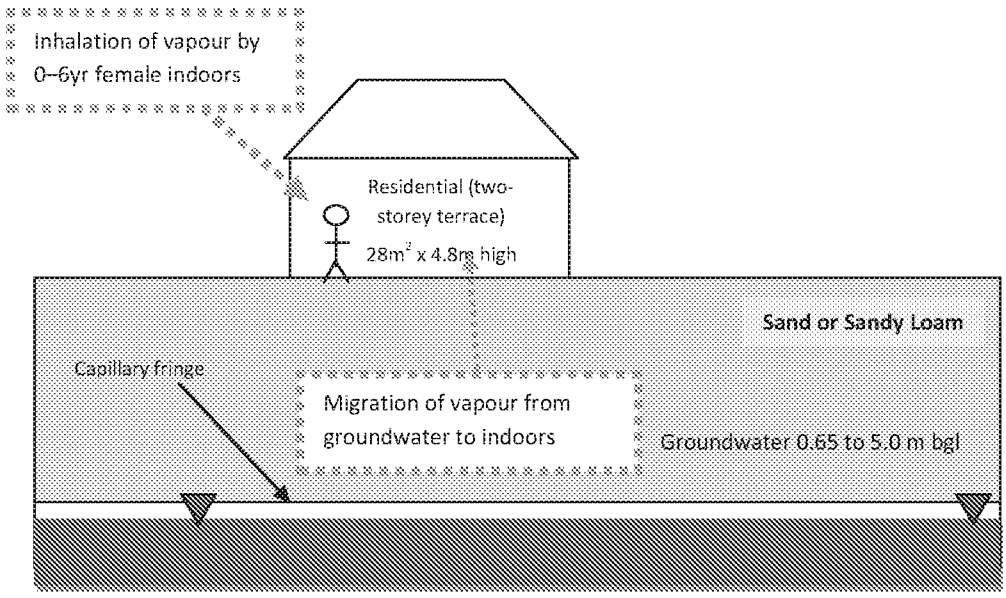
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Generic groundwater assessment criteria (GrAC) for human health: residential scenario (child receptor)

Background

Volatile organic compounds (VOC) in groundwater have the potential to pose risks to residential site end users via indoor and outdoor inhalation exposure. Due to significant dilution effects in outdoor air, inhalation risk is dominated by indoor exposure. The GrAC conceptual site model (CSM) is shown in Figure 1 (not to scale).

Figure 1: GrAC conceptual model for a generic residential scenario



RSK GrAC derivation

Model selection

The Society for Brownfield Risk Assessment (SoBRA) published a set of generic assessment criteria for assessing vapour risk to human health from volatile contaminants in groundwater in February 2017[(1)]. The criteria were developed for a list of common VOC using the Environment Agency Contaminated Land Exposure Assessment (CLEA) tool[(2)] based on a sand soil type and a groundwater depth of 0.65 m below foundation base level. The CLEA tool is not designed to directly model VOC in groundwater and the SoBRA generic criteria are recognised as being conservative since calculations in CLEA are based on three-phase partitioning in the unsaturated zone between soil, soil vapour and soil moisture, with the latter taken by SoBRA as a groundwater equivalent. This method does not take account of the presence of a semi-saturated capillary fringe above the water table, which will serve to provide some mitigation to vertical soil vapour migration.

RSK GrAC are calculated using the RBCA Toolkit for Chemical Releases (version 2.6) with the Johnson and Ettinger model, based on the CSM in Figure 1 for a small terrace house (as defined in SR3[(3)], Table 4.21) and which allows consideration of a capillary fringe. The capillary fringe is

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the subsurface layer in which groundwater seeps up from a water table by capillary action to partially fill soil pores.

The RBCA model was used in preference to the Environment Agency Contaminated Land Exposure Assessment (CLEA) tool[2], as the CLEA tool is not designed to directly model VOC in groundwater and does not take account of the presence of a capillary zone.

Conceptual model

In accordance with SR3[3], the residential scenario considers risks to a female child between the ages of 0 and 6 years old as the highest risk scenario.

The pollutant linkage considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by residents while indoors. Figure 1 illustrates this linkage. Although the outdoor air inhalation pathway is also valid, this contributes little to the overall risks owing to the dilution of VOC in outdoor air. RBCA does not take direct account of the presence of VOC from non-aqueous phase chemicals but highlights when the assessment criterion exceeds the solubility limit of the pure compound.

Input selection – chemical and toxicological parameters

Key parameters used in the RBCA model are listed and justified in Table 1. The most up-to-date published chemical and toxicological data was obtained from EA Report SC050021/SR7[2], the EA TOX[5] reports, and published by Nathanial et al.,[6], as appropriate. Toxicological and specific chemical parameters for 1,2,4-trimethylbenzene and methyl tertiary-butyl ether (MTBE) were obtained from the CL:AIRE Soil Generic Assessment Criteria report[7].

The toxicological input parameters are associated with minimal risk, rather than low risk.

For petroleum hydrocarbon fractions, aromatic hydrocarbons C5–C8 were not modelled, as this range comprises benzene (>EC5-EC7) and toluene (>EC7-EC8), which are modelled separately.

For the GrAC, the Health Criteria Values (HCV) used in the modelling were derived using the toxicological data for the Soil Assessment Criteria, amended as follows:

- A child weighing 13.3kg (average of 0-6 year old female in accordance with Table 4.6 of SR3[3]) and breathing 8.77m^3 (average daily inhalation rate for a 0-6yr old female in accordance with SP1010 final project report for the C4SL (Table 3.2[8]) and USEPA data[9]
- Background inhalation (mean daily intake (MDI)) for a child (Age Classes 1-6)
- Residential amendments to the MDI for younger age groups following Table 3.4 and Section 3.4.1 of SR2[10],; amended to reflect average daily inhalation rates in accordance with SP1010 final project report for the C4SL (Table 3.2[8]) and USEPA data[9]. Correction factors are presented in Table 1.

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Table 1: Correction factors used to adjust adult MDI to younger age groups

Age Class	Body weight (kg)[1]	Inhalation rate (m^3/day)[2]	Correction factor for inhalation MDI[3]
1	5.6	5.4	0.34
2	9.8	8	0.51
3	12.7	8.9	0.57
4	15.1	10.1	0.64
5	16.9	10.1	0.64
6	19.7	10.1	0.64
17	70	15.7	-
Mean (AC1-6)	**13.3**	**8.8**	**0.56**

Notes
[1] Body weight from CLEA v1.071
[2] Inhalation rate from Table 3.2 of the SP1010 final project report for the C4SL[(8)]
[3] Inhalation correction factors are the ratio of the average male and female inhalation rates for each age class to the adult rate at age class 17 (age 16–59 years) and are based on the rates used by the Category 4 Screening Levels to derive the C4SLs[(8)],following the methodology in SR2[(10)].

The amended HCV used in the derivation of the RSK GrAC are presented in Table 2.

Note on Trimethylbenzenes

For trimethylbenzenes the CL:AIRE report[(7)] based background inhalation from non-soil sources (MDI) on a Dutch study from 1985, which is reported to have identified an average daily dose of 1,2,4-trimethylbenzene of 86 ug d^{-1} (1,3,5-trimethylbenzene was 20.5 ug d^{-1}). This dose value was based on the upper end of the identified concentration range of 1,2,4-trimethylbenzene (2.46 – 5.66 ug m^{-3}) and was used to calculate an a MDI of 1.23 ug kg^{-1} bw d^{-1} for a 70 kg adult breathing 20 m^3 of air daily.

The approach recommended in SR2[(10)], and also adopted for the C4SLs[(8)], for non-carcinogenic (threshold) compounds such as trimethylbenzenes is to subtract the MDI from the tolerable daily intake (TDI) to obtain a tolerable daily intake from soil (TDSI) in units of ug kg^{-1} bw d^{-1}. For 1,2,4-trimethylbenzene, the adult MDI from the Dutch study used in the CL:AIRE report[(7)] (1.23 ug kg^{-1} bw d^{-1}) is a significant proportion of the TDI (2.0 ug kg^{-1} bw d^{-1}), resulting in a low TDSI (1.0 ug kg^{-1} bw d^{-1}) when the 50% rule is applied (i.e. TDSI = TDI * 0.5 when MDI is high relative to TDI). This TDSI equates to an Inhalation Reference Concentration (or modified Health Criteria Value) for adults of 3.4 ug m^{-3} (70 kg adult breathing 15.7 m^3 d^{-1}).

By comparison the adult inhalation modified HCV for benzene is 6.2 ug m^{-3}, which is proven human carcinogen (non-threshold compound).

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Table 2: Amended Health Criteria Values

	Modified HCV (mg/m^3)
VOC / SVOC	Child (Residential)
MTBE	1.0803
Benzene	0.0021
Toluene	2.1164
Ethylbenzene	0.1113
Xylenes	0.0834
Trimethybenzenes	0.0026
TPH_Aliph EC5-EC6	3.7913
TPH_Aliph >EC6-EC8	3.7913
TPH_Aliph >EC8-EC10	0.2199
TPH_Aliph >EC10-EC12	0.2199
TPH_Aliph >EC12-EC16	0.2199
TPH_Arom >EC8-EC10	0.0455
TPH_Arom >EC10-EC12	0.0455
TPH_Arom >EC12-EC16	0.0455
Acenaphthene	0.0910
Acenaphthylene	0.0910
Naphthalene	0.0011
Vinyl chloride	0.0005
Dichloroethane-1,2	0.0002
Tetrachloroethene	0.0083
Carbon tetrachloride	0.0025
Trichloroethane-1,1,1	0.9099
Trichloroethene	0.0009
Tetrachloroethane 1,1,2,2 & 1,1,1,2	0.0086
1,1,2-Trichloroethane	0.0073
1,1-dichloroethene	0.0864
Chloroethane	4.3318
Chloromethane	0.0039
Dichloromethane	0.1761

The MDI for 1,2,4-trimethylbenzene is considered by RSK to be overly conservative for the following reasons:

- The Dutch 1985 study is dated and air quality has improved since this time
- The maximum value in the range (5.66 ug m^{-3}) was used in calculating the MDI
- Experience has shown that trimethylbenzenes often appear to drive inhalation risks to a greater extent than benzene, even though the latter is carcinogenic and more volatile.

As an alternative to the 1985 Dutch study, RSK have obtained automated roadside air quality monitoring data for the UK from www.uk-air.defra.gov.uk/. The average concentration of 1,2,4-trimethylbenzene measured during 2015 at Eltham, south-east London (urban) was 0.309 ug m^{-3},

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significantly lower than that identified in the Dutch study and used by CL:AIRE[7] for calculation of a MDI. Whilst an average concentration of 1,2,4-trimethylbenzene in UK urban and rural areas is likely to be significantly below 0.0.309 ug m^{-3}, this value is considered to be suitably conservative for the calculation of a modified HCV for trimethylbenzenes in the UK.

On this basis, the HCV for 1,2,4-trimethylbenzene for adults and children was calculated as 8.5 ug m^{-3} (0.0085 mg m^{-3}) and 2.6 ug m^{-3} (0.0026 mg m^{-3}), respectively (see Table 3). Due to the paucity of toxicological data for 1,2,3-trimethylbenzene and 1,3,5-trimethylbenzene the modified HCV for 1,2,4-trimethylbenzene is considered suitable for assessing total trimethylbenzenes.

Note on aqueous solubility and the RSK GrAC

Where the modelled assessment criteria, or the modelled assessment criteria with the correction factor applied to those contaminants specified below, exceeds the aqueous solubility limit the assessment criteria defaults to this concentration and consequently the GrAC is set at the limit of solubility. These assessment criteria are shaded in red in Table 4.

The theoretical aqueous solubility is the maximum amount of a single chemical that will dissolve in pure water at a specified temperature. Above this concentration, the chemical will exist in the non-aqueous phase (i.e. in its natural physical form as a solid, liquid (NAPL) or gas). If the contaminant, based on its toxicity, is not considered to pose a risk to human health at the aqueous solubility concentration then the contaminant can be considered not to pose a risk to human health. Where the GrAC is set at the aqueous solubility limit (shaded in red on Table 4), this is not a risk based assessment criteria but is indicative of the maximum amount of chemical that would be found dissolved in the water. Therefore an exceedance of the RSK GrAC set at the aqueous solubility limit is <u>not</u> indicative that there may be potential risks to human health. It should be noted that for certain contaminants (e.g. the lighter petroleum hydrocarbon fractions) the aqueous solubility is very low and may be at, or below, the laboratory method detection limit. It should also be noted that non-aqueous phase may exist where concentrations of individual compounds are well below their solubility limits where they are part of a mixture, in accordance with Raoult's Law.

Input selection - physical parameters

For the residential scenario, the CLEA default building is a small, two-storey terrace house with a concrete ground-bearing slab as detailed in Table 3. Environment Agency document SR3[3] notes this residential building type to be the most conservative in terms of potential for vapour intrusion. The building parameters used in the production of the RSK GrACs are the default CLEA v1.071 inputs presented in Table 3.3 of SR3[3].

The RSK GrAC have been calculated for both Sand and Sandy Loam soils. The soil parameters used in the derivation of the RSK GrAC are those presented in Table 3.1 of SR3[3].

The RSK GrAC have been derived for groundwater depths of 0.65 m, 1.5 m, 2.5 m and 5.0 m below ground level, incorporating a capillary fringe (see Table 4).

Input selection - attenuation factors

In line with recommendations provided in Environment Agency SR3[3] a sub-surface to indoor attenuation factor of 10 has been applied to certain RBCA derived 'site-specific target levels'. SR3[3] states that, as a general rule of thumb, it is recognised that estimating vapour phase concentrations from dissolved and sorbed phase petroleum hydrocarbons by using partition

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coefficients are at least a factor of ten higher than those likely to be measured on-site. This difference is likely to be due to a number of factors, however aerobic biodegradation in the unsaturated zone is believed to be largely responsible. RSK has therefore applied this attenuation factor to all volatile petroleum hydrocarbon fractions (including BTEX, tri-methylbenzenes and the polycyclic aromatic hydrocarbons (PAH) naphthalene, acenaphthene and acenaphthylene). No such attenuation factors have been applied to other non-hydrocarbon chemical species, including chlorinated hydrocarbons or fuel oxygenates such as MtBE.

Convective (volumetric) air flow through foundation cracks (Q_{soil}) is a sensitive parameter in the calculation of GrAC and has been calculated within RBCA on a soil-specific basis for Sand and Sandy Loam in a residential exposure scenario (see Table 3). This approach is less conservative than using the default Q_{soil} value recommended in SR3[3] for a Sandy Loam (25 cm^3 s^{-1}) and used in the CLEA model (version 1.071) for Sandy Loam (and Sand) soils (25 cm^3 s^{-1}) in a residential scenario.

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Table 3: Residential scenario – RBCA inputs

Parameter	Unit	Value	Justification
Receptor – female child			
Averaging time	Years	6	From Box 3.1, SR3[3]
Receptor weight	kg	13.3	Average of CLEA 0-6 year old female data, Table 4.6, SR3[3]
Exposure duration	Years	6	From Box 3.1, report , SR3[3]
Exposure frequency	Days yr^{-1}	350	Weighted using occupancy period of 23 hours per day for 365 days of the year
Soil type – sand			
Total porosity	-	0.54	CLEA value for sand. Parameters for sand from Table 4.4, SR3[3]. Volumetric water content in the vadose zone is a highly sensitive parameter within the model and potentially highly variable in the field.
Volumetric water content – unsaturated (vadose) zone	-	0.24	
Volumetric air content - unsaturated (vadose) zone	-	0.30	
Dry bulk density	g cm^{-3} or kg L^{-1}	1.18	
Volumetric water content – capillary zone	-	0.35	Calculated using SR3 Equation 4.1. Value taken as the average moisture content calculated for suction heads (cm H_2O); 0 (i.e. saturated), 10, 20, 30, 40, 50 (i.e. unsaturated soil at field capacity). This is a highly sensitive parameter within the model.
Volumetric air content - capillary zone	-	0.19	Calculated from total porosity and volumetric water content of capillary zone. This is a highly sensitive parameter within the model.
Vertical hydraulic conductivity	cm d^{-1}	636	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3[3] equivalent to 7.36 E-03 cm s^{-1}
Vapour permeability	m^2	7.54 E-12	Calculated for sand using equations in Appendix 1, SR3[3]
Capillary zone thickness	m	0.25	Taken from C W Fetter, Applied Hydrogeology 4th Ed, 1994[11] and R Heath, Basic groundwater hydrology 1992[12] for a medium sand
Fraction organic carbon	%	0.0058	Equivalent to SOM = 1%. Note that GrAC are independent on FOC/SOM content since partitioning is assumed to be between aqueous and vapour phases only
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3[3]. Volumetric water content in the vadose zone is a highly sensitive parameter within the model and potentially highly variable in the field.
Volumetric water content – unsaturated (vadose) zone	-	0.33	
Volumetric air content - unsaturated (vadose) zone	-	0.20	
Dry bulk density	g cm^{-3} or kg/L	1.21	
Volumetric water content – capillary zone	-	0.42	Calculated using SR3 Equation 4.1[3]. Value taken as the average moisture content calculated for suction heads (cm H_2O); 0 (i.e. saturated), 10, 20, 30, 40, 50 (i.e. unsaturated soil at field capacity). This is a highly sensitive parameter within the model.
Volumetric air content - capillary zone	-	0.11	Calculated from total porosity and volumetric water content of capillary zone. This is a highly sensitive parameter within the model.

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Parameter	Unit	Value	Justification
Vertical hydraulic conductivity	cm d^{-1}	308	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3[3] equivalent to 3.56E-3 cm s^{-1}
Vapour permeability	m^2	3.05 E-12	Calculated for sandy loam using equations in Appendix 1, SR3[3]
Capillary zone thickness	m	0.4	Taken from R Heath, Basic Groundwater Hydrology 1992[12] for a fine sand. Note: C W Fetter, Applied Hydrogeology 4th Ed, 1994[11] value for fine sand is 0.5 m
Fraction organic carbon	%	0.0058	Equivalent to SOM = 1%. Note that GrAC are independent on FOC/SOM content since partitioning is assumed to be between aqueous and vapour phases only
Building – small terrace house			
Building volume/area ratio	m	4.8	Table 3.3, SR3[3]
Foundation area	m^2	28	
Foundation perimeter	m	21.16	Calculated using Equation A2 in SR3[3], which assumes the building to be of square proportions.
Building air exchange rate	d^{-1}	12	Table 3.3, SR3[3] Building air exchange rate equivalent to 1.4 E-04 s^{-1}
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	
Foundation crack fraction	-	0.00151	Calculated from floor crack area of 423cm^2 and building footprint of 28m^2 in Table 4.21, SR3[3]
Volumetric water content of cracks	-	0.24 / 0.33	For sand / sandy loam, assumed equal to underlying soil type in assumption that cracks become filled with unsaturated zone soil over time. Parameters for sand and sandy loam from Table 4.4, SR3[3]
Volumetric air content of cracks	-	0.30 / 0.20	
Indoor/outdoor differential pressure	Pa	3.1	From Table 3.3, SR3[3] Equivalent to 31 g/cm/s^2
Convective air flow through cracks (Q_{soil}) - Sand	m^3 s^{-1}	3.4 E-05	Soil-specific calculated parameter in RBCA equivalent (and cross checked) with equations A1, A2, A3, A8, A9 in SR3[3]. Equivalent to **34 cm^3 s^{-1}**
Convective air flow through cracks (Q_{soil}) – Sandy Loam	m^3 s^{-1}	1.4 E-05	Soil-specific calculated parameter in RBCA equivalent (and cross checked) with equations A1, A2, A3, A8, A9 in SR3[3]. Equivalent to **14 cm^3 s^{-1}**

RSK GrAC derivation outputs

The RSK GrACs are presented in Table 4.

Within the RSK GrAC the following should be noted:

- GrAC do not take account of outdoor inhalation exposure to VOC, which is considered to contribute minimally to overall inhalation exposure
- GrAC do not take account of other exposure routes potentially relevant to VOC in shallow groundwater such as direct contact or root uptake
- No biodegradation is assumed to occur in the unsaturated zone. Where aerobic conditions on site are known to exist the GrAC for hydrocarbons may therefore be conservative
- GrAC do not take account of preferential flow into buildings such as through unsealed service entries. In such circumstances GrAC may not be appropriate for use
- GrAC are based on a soil vapour intrusion CSM and are not appropriate for use when the foundation is in direct contact with contaminated groundwater

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- GrAC assume that the capillary fringe is un-contaminated with VOC, which is unlikely, particularly where groundwater levels are variable
- GrAC set at the theoretical aqueous solubility limit are not considered to pose a risk to human health
- GrAC do not take into account the interaction between contaminants and the influence this may have on the theoretical aqueous solubility
- GrACs are only applicable to dissolved phase contaminants where the modelled assessment criteria is below the aqueous solubility limits

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	Table 4: RSK GrAC (ug/l)							
	RESIDENTIAL							
	SAND				SANDY LOAM			
GW Depth (m)	0.65	1.5	2.5	5	0.65	1.5	2.5	5
Metals								
Elemental mercury	2.5	3.6	5.0	8.4	14.3	18.5	23.4	35.8
Methyl mercury	21550	27220	33880	50540	46300	48510	51110	57610
Volatile Organic Compounds								
Benzene	470	670	900	1490	2900	3640	4510	6680
Toluene	515140	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ethylbenzene	24300	35190	48000	80020	156380	[illegible]	[illegible]	[illegible]
Xylene - m	22610	32750	44670	74480	144250	181800	[illegible]	[illegible]
Xylene - o	27570	39950	54500	90900	174260	[illegible]	[illegible]	[illegible]
Xylene - p	23640	34230	46700	77860	150470	189710	[illegible]	[illegible]
Total xylene	22610	32750	44670	74480	144250	[illegible]	[illegible]	[illegible]
Methyl tertiary-Butyl ether (MTBE)	185010	267500	364520	607070	945700	1245710	1598660	2481040
Trichloroethene	13	18	25	41	82	100	130	190
Tetrachloroethene	80	120	160	260	520	650	810	1200
1,1,1-Trichloroethane	7110	10230	13910	23090	46230	57820	71450	105540
1,1,1,2 Tetrachloroethane	550	800	1100	1830	3330	4250	5330	8040
1,1,2,2-Tetrachloroethane	3620	5320	7320	12320	14600	20600	27650	45290
Carbon Tetrachloride	12	17	24	39	79	98	120	180
1,2-Dichloroethane	20	28	38	63	100	140	170	260
Vinyl Chloride	1.3	1.8	2.4	4.0	8	10	12	18
1,2,4-Trimethylbenzene	980	1430	1960	3270	6240	7900	9850	14720
Semi-Volatile Organic Compounds								
Acenaphthene	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Acenaphthylene	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Naphthalene	5100	7530	10380	17510	[illegible]	[illegible]	[illegible]	[illegible]
Petroleum Hydrocarbons								
Aliphatic hydrocarbons EC5-EC6	4170	5900	7930	13020	26560	32990	[illegible]	[illegible]
Aliphatic hydrocarbons >EC6-EC8	3210	4540	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aliphatic hydrocarbons >EC8-EC10	120	170	230	380	[illegible]	[illegible]	[illegible]	[illegible]
Aliphatic hydrocarbons >EC10-EC12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aliphatic hydrocarbons >EC12-EC16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aromatic hydrocarbons >EC8-EC10	4150	5870	7900	12960	25730	32120	39630	58400
Aromatic hydrocarbons >EC10-EC12	14480	20510	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Aromatic hydrocarbons >EC12-EC16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Notes:

Values less than 100 have not been rounded up or down; values greater than 100 have been rounded to the nearest 10.

[illegible] pure compound in water (aqueous solubility); GrAC defaults to the limit of solubility.

No vadose zone biodegradation considered

Sub-surface to indoor air correction factor of 10 applied to all petroleum (non-chlorinated) hydrocarbons

All GrAC are for 1% SOM (0.0058 FOC)

APPENDIX H
GENERIC ASSESSMENT CRITERIA FOR PHYTOTOXIC EFFECTS

Several compounds can inhibit plant growth; hence it is important to have generic assessment criteria (GAC) to promote healthy plant growth. In the absence of other published GAC, the GAC have been obtained from legislation (UK and European) and guidance related to the use of sewage sludge on agricultural fields.

The Council of European Communities Sewage Sludge Directive (86/278/EEC) dated 1986, has been transposed into UK law by Statutory Instrument No. 1263, The Sludge (use in Agriculture) Regulations 1989 (Public Health England, Wales and Scotland), as amended in 1990 and The Sludge (use in Agriculture) Regulations (Northern Ireland) SR No, 245, 1990. In addition, the Department of Environment (DoE) produced a Code of Practice (CoP) (Updated 2nd Edition) in 2006 which provided guidance on the application of sewage sludge on agricultural land (however the status of this document is unclear as it is on the archive section of the Defra website).

The directive seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to "***prevent harmful effects on soil, vegetation, animals and man***". To this end, it prohibits the use of untreated sludge on agricultural land unless it is injected or incorporated into the soil. Treated sludge is defined as having undergone "biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use". To provide protection against potential health risks from residual pathogens, sludge must not be applied to soil in which fruit and vegetable crops are growing, or less than ten months before fruit and vegetable crops are to be harvested. Grazing animals must not be allowed access to grassland or forage land less than three weeks after the application of sludge.

The specified limits of concentrations of selected elements in soil are presented in Table 4 of the updated 2nd Edition of the DoE Code of Practice and are designed to protect plant growth. It is noted that these values are more stringent than the values set in current UK regulations. However since they were amended following recommendations from the Independent Scientific Committee in 1993. (MAFF/DOE 1993). The GAC are presented in Table 1.

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Table 1: Generic assessment criteria

Determinant	Generic assessment criteria (mg/kg)			
	pH 5.0 < 5.5	pH 5.5 < 6.0	pH 6.0 < 7.0	pH >7.0
Zinc	200	200	200	300
Copper	80	100	135	200
Nickel	50	60	75	110
Lead	300	300	300	300
Cadmium	3	3	3	3
Mercury	1	1	1	1

Note: Only compounds with assessment criteria documented within the Directive 86/278/EEC have been included, although criteria for 5 additional compounds have been presented within the 2006 CoP.

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APPENDIX I
GENERIC ASSESSMENT CRITERIA FOR CONTROLLED WATERS

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GENERIC ASSESSMENT CRITERIA FOR CONTROLLED WATERS

Protection of the water environment

The water environment in the United Kingdom is protected under a number of regulatory regimes. The relevant environmental regulator is consulted where there may be a risk that pollution of 'controlled waters' may occur or may have occurred in the past.

The term 'controlled waters' refers to coastal waters, inland freshwaters and groundwater. The EU Water Framework Directive (WFD) (2000/60/EC) is implemented via domestic regulations and guidance, covering aspects of groundwater and surface water protection as well as drinking water supply policy. Domestic legislation and guidance will vary across the United Kingdom. Therefore, the relevant legislation for England, Wales, Northern Ireland and Scotland should be reviewed, alongside guidance provided by the Environment Agency (EA), Natural Resource Wales (NRW), the Scottish Environmental Protection Agency (SEPA) or the Northern Ireland Environment Agency (NIEA), as appropriate.

The main objectives of the protection and remediation of groundwater under threat from land contamination are set out within "The Environment Agency's approach to groundwater protection", version 1.0 (March 2017)(1) and the associated guidance "Land contamination groundwater compliance points: quantitative risk assessments (March 2017)(1a) that have replaced the previous guidance document "Groundwater Principles and Practice (GP3)". When assessing risks to groundwater, the following need to be considered:

- Where pollutants have not yet entered groundwater, all necessary and reasonable measures must be taken to:
  - ***prevent*** *the input of* ***hazardous*** *substances into groundwater (see description of hazardous substances below)*
  - ***limit*** *the entry of other (non-hazardous) pollutants into groundwater to avoid pollution, deterioration in the status of groundwater bodies and to prevent sustained, upward trends in pollutant concentrations in groundwater.*
- Where pollutants have already entered groundwater, the priority is to take all necessary and reasonable measures to:
  - ***minimise*** *further entry of "contaminants" where there is a defined source*
  - ***limit the pollution*** *of groundwater or any effect on the status of the groundwater body from the future expansion of the 'plume', if necessary, by actively reducing its extent.*

Within the context of groundwater risk assessments on sites affected by land contamination, "reasonable" means feasible without involving disproportionate costs. What costs are "disproportionate" depends on site-specific circumstances, which may include:

- Considerations of technical feasibility such as identified by the remedial options appraisal, this may be due to the distribution or nature of the contamination and the available remedial methods to treat the identified contamination;
- Sustainability considerations.

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DEFINITIONS AND SUBSTANCE CLASSIFICATIONS

Risks to surface waters:

When assessing risks to surface waters, the following list of definitions should be understood:

Priority substances (PS) are harmful substances originally identified under the Water Framework Directive (WFD) 2000/60/EC as substances 'presenting a significant risk to or via the aquatic environment' at a European level. Member States are required to incorporate the identified **PS** into their country-wide monitoring programmes. There are currently 33 **PS** defined within the Priority Substances Directive (2013/39/EU, Annex 1), with a further 12 additional substances due to come into force from 22 December 2018. Directive 2013/39/EU has been transposed into domestic legislation for England and Wales by The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

Under the umbrella of **PS**, there is a sub-set of substances identified as being 'hazardous', and these are referred to as **Priority hazardous substances (PHS)**. The list of **PHS** is defined at EU level within the Priority Substances Directive (2013/39/EU). The WFD defines hazardous substances as 'substances (or groups of substances) that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances that give rise to an equivalent level of concern.' There are currently 15 **PHS**, with a further 6 additional substances due to come into force from 22 December 2018.

There is also another group of substances defined at EU level and which are referred to as **other pollutants (OP)** in Directive 2013/39/EU. These are additional substances which although not **priority substances**, have EQS which are identical to those laid down in the legislation which applied prior to 13 January 2009 (Directive 2008/105/EU). The **OP** are listed along with the **priority substance (PS)** within the Priority Substances Directive (2013/39/EU) and their associated EQS are also listed therein. There are 5 **OP** defined within the Priority Substances Directive (2013/39/EU).

In addition to the EU level substances, there are also a group of pollutants defined at a Member State level, referred to as **Specific pollutants (SP)**. These substances are pollutants which are released in significant quantities into water bodies in each of the individual European Member States. Under the WFD, Member States are required to set their own EQS for these substances. An indicative list of **SP** is given in Annex VIII of the WFD. Many of the substances categorised as **SP** in the UK were formerly List 2 substances under the old Groundwater Directive (80/68/EEC). The **SP** are defined within Part 2 (Table 1) of The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

Risks to groundwater:

When assessing risks to groundwater, the following definitions should be understood:

Under the requirements of the Groundwater Daughter Directive (2006/118/EU), the UK has published a list of substances it considers to be **hazardous substances** with respect to groundwater. In their advisory capacity to the government, this list has been derived by the UK Joint Agencies Groundwater Directive Advisory Group (JAGDAG), of which the Environment Agency is a member. The JAGDAG list of **hazardous substances** was published in January 2017 and the Environment Agency will use the updated list of hazardous substances from this date for all new activities that may lead to the discharge of hazardous substances to groundwater. The list is extensive and can be found in full at:

https://www.wfduk.org/stakeholders/wg/jagdag

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Selecting the appropriate assessment criteria

When assessing the risks to controlled waters, various assessment criteria apply, depending on the nature of the assessment and the conceptual site model.

Where a surface water body is involved, then Environmental Quality Standards (EQS) are the relevant assessment criteria as they are designed to be protective of surface water ecology.

Where a public water supply or a Principal aquifer is involved, then the standards defined in The Water Supply (Water Quality) Regulations[2] are the primary source of assessment criteria. The Private Water Supplies Regulations[3] may also be applicable in some cases. For instances where there are no UK assessment criteria, then the World Health Organisation (WHO) drinking water guidelines[4] may be used.

This appendix presents the generic assessment criteria (GAC) that RSK considers suitable for assessing risks to controlled waters for our most commonly encountered determinants. A full list of EQS for England and Wales are included in The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

The RSK GAC for controlled waters are presented in **Table 1** and **Table 2**. In line with the Environment Agency's Remedial Targets Methodology, the GAC for controlled waters are termed 'target concentrations'.

The appropriate target concentrations should be selected with consideration to:

- the site conceptual model (i.e. the receptor at potential risk);
- whether the substance is already present in groundwater at the site;
- whether or not the substance is classified as a priority hazardous substance under the Priority Substances Directive (2013/39/EC) (see above), or as a hazardous substance according to the current list of JAGDAG determinations[5]; and
- background concentrations in the aquifer (if applicable).

It is important to remember that the WFD and Environment Agency guidance[1 & 1a] support a sustainable, risk-based approach be applied to groundwater contamination. Exceedance of any target concentration does not necessarily imply that an unacceptable risk exists or that remediation is inevitably required.

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Target concentrations shaded in green are statutory values	Target concentrations shaded in orange are non-statutory values

Note: Units µg/l throughout (unless otherwise stated)

Table 1: Target concentrations for controlled waters (excluding TPH CWG fractions)

Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[3]	Surface water receptors[3]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters
Metals & other inorganics						
Hazardous substance	Specific pollutant	Arsenic	-	10[2]	50[6a]	25[6a]
Non-hazardous pollutant	Priority substance	Cadmium	0.1[7]	5[2]	≤0.08, 0.08, 0.09, 0.15, 0.25 [6b]	0.2[6a]
(Not determined)	-	Chromium (total)	-	50[2]	8.1 Sum values for chromium III and VI	-
(None	Specific pollutant	Chromium (III)	-	Use value for total chromium	4.7[6a]	-
Hazardous substance	Specific pollutant	Chromium (VI)			3.4[6a]	0.6[6a]

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Substance classification		Determinant	Minimum reporting value	Target concentrations (µg/l)		
					EQS or best equivalent	
Groundwater receptors[3]	Surface water receptors[3]			UK drinking water standard (or best equivalent)	Freshwater	Transitional (estuaries) and coastal waters
(Not determined)	Specific pollutant	Copper	-	2,000[2]	1 bioavailable[5a]	3.76 dissolved, where DOC ≤1mg/l[5a] 3.76µg/l + (2.677µg/l x ((DOC/2) – 0.5µg/l)) dissolved, where DOC >1mg/l[5a]
Hazardous substance	Priority substance	Lead	-	10[2]	1.2 bioavailable[5a]	1.3[5a]
Hazardous substance	**Priority hazardous substance**	Mercury	0.01[7]	1[2]	0.07[5c]	0.07[5c]
Non-hazardous pollutant	Priority substance	Nickel	-	20[2]	4.0 bioavailable[5a]	8.6[5a]
Non-hazardous pollutant	-	Selenium	-	10[2]	-	-
Non-hazardous pollutant	Specific pollutant	Zinc	-	3,000[8]	10.9 bioavailable[5a]	6.8 dissolved [5a]
None	Specific pollutant	Iron	-	200[2]	1000[5a]*1	1000[5a])*1
None	Specific pollutant	Manganese	-	50[2] (0.05mg/l)	123 bioavailable[5a] (0.123mg/l)	-
(Not determined)	-	Aluminium	-	200[2]	-	-

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Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[9]	Surface water receptors[9]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters
Hazardous substance	**Priority hazardous substance**	Tributyltin compounds (Tributyltin-cation)	0.001[7]	-	0.0002[6a]	0.0002[6a]
(Not determined)	-	Sodium	-	200,000[2] (200 mg/l)	-	-
Non-hazardous pollutant	Specific pollutant	Cyanide (Hydrogen cyanide)	-	50[2] (0.05 mg/l)	1[6a] (0.001 mg/l)	1[6a] (0.001 mg/l)
Non-hazardous pollutant	-	Total ammoniacal nitrogen[$]	-	500[2] (0.5 mg/l) as NH_4 (472 expressed as NH_3; 389 expressed as N)	300[6f] (0.3 mg/l) as N (364 expressed as NH_3; 386 expressed as NH_4)	-
Non-hazardous pollutant	Specific pollutant	Ammonia un-ionised (equilibrium ratio calculated) (NH_3)	-	-	-	21[6a] (0.021 mg/l)
Non-hazardous pollutant	Specific pollutant	Chlorine	-	-	2[6a] (0.002 mg/l)	10[6d] (0.01 mg/l)
(Not determined)	-	Chloride	-	250,000[2] (250 mg/l)	-	-
(Not determined)	-	Sulphate	-	250,000[2] (250 mg/l)	-	-
(Not determined)	-	Nitrate (as NO_3)	-	50,000[2] (50 mg/l)	-	-

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Substance classification		Determinant	Target concentrations (µg/l)			
			Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
Groundwater receptors[9]	Surface water receptors[9]				Freshwater	Transitional (estuaries) and coastal waters
(Not determined)	-	Nitrite (as NO_2)	-	500[2] (0.5 mg/l)	10[9] (0.01 mg/l)	-
Volatile organic compounds (VOC)						
Non-hazardous pollutant	Other pollutant	Tetrachloroethene (tetrachloroethylene; PCE)	0.1[7]	10[2] sum of TCE and PCE	10[5a]	10[5a]
Hazardous substance	Other pollutant	Trichloroethene (trichloroethylene; TCE)	0.1[7]		10[5a]	10[5a]
None	Specific pollutant	Tetrachloroethane	-	-	140[6a]	-
Hazardous substance	Other pollutant	Carbon tetrachloride (tetrachloromethane)	0.1[7]	3.0[2]	12[6a]	12[6a]
Non-hazardous pollutant	Priority substance	1,2-Dichloroethane	1.0[7]	3.0[2]	10[6a]	10[6a]
Non-hazardous pollutant	-	1.2-Dichloroethene (DCE) sum of cis and trans	-	50.0[4]	-	-
Hazardous substance	-	Vinyl chloride (chloroethene)	-	0.5[2]	-	-
Non-hazardous pollutant	Priority substance	Dichloromethane	-	20[4]	20[5a]	20[5a]
Non-hazardous pollutant	Priority substance	Trichlorobenzenes	0.01[7]	-	0.4[6a]	0.4[(6a)]

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Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[9]	Surface water receptors[9]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters
Hazardous substance	Priority substance	Trichloromethane (Chloroform)	0.1[7]	100[2a] (sum of **trihalomethanes** – chloroform, bromform, dibromochloromethane, bromodichloromethane)	2.5[6a]	2.5[6a]
(Not determined)	-	Bromoform	-		-	-
(Not determined)	-	Dibromochloromethane	-		-	-
(Not determined)	-	Bromodichloromethane	-		-	-
Non-hazardous pollutant	**Priority hazardous substance**	Di(2-ethylhexyl) phthalate (bis(2-ethylhexyl) phthalate, DEHP)	-	8[4]	1.3[6a]	1.3[6a]
None	Specific pollutant	Benzyl butyl phthalate	-	-	7.5[6a]	0.75[6c]
Hazardous substance	**Priority hazardous substance**	Hexachlorobutadiene (as a pesticide, but reported in a VOC suite)	0.005[7]	0.1[2]	0.6[6c]	0.6[6c]
Semi-volatile organic compounds (SVOC)						
(Not determined)	-	Acenaphthylene (Aro EC12-EC16)	-	-	5.8[10]	
Hazardous substance	**Priority hazardous substance**	Anthracene (Aro EC16-EC21)	-	-	0.1[6a]	0.1[6a]

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Substance classification		Determinant	Target concentrations (µg/l)			
			Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
Groundwater receptors[3]	Surface water receptors[3]				Freshwater	Transitional (estuaries) and coastal waters
Non-hazardous pollutant	Priority substance	Naphthalene (Aro EC10-EC12)	-	-	2[6a]	2[6a]
Hazardous substance	Priority substance	Fluoranthene (Aro EC21-EC35) not used as an indicator for this EC band	-	-	0.0063[6a]	0.0063[6a]
Hazardous substance(s)	**Priority hazardous substance(s)**	Benzo(a)pyrene (Aro EC21-EC35)	-	0.01[2]	0.00017[6a]	0.00017[6a]
		Benzo(b)fluoranthene (Aro EC21-EC35)	-	0.1[2] sum of the concentration of the four specified compounds	No EQS for these substances. B(a)P should be used as the indicator compound instead.	
		Benzo(k)fluoranthene (Aro EC21-EC35)	-			
		Benzo(g,h,i)perylene (Aro EC21-EC35)	-			
		Indeno(1,2,3-cd) pyrene (Aro EC21-EC35)	-			
Non-hazardous pollutant	Specific pollutant	Phenol	-	-	7.7[6a]	7.7[6a]
Hazardous substance	Specific pollutant	2,4-Dichlorophenol	0.1[7]	-	4.2[6a]	0.42[5a]

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Substance classification		Determinant	Target concentrations (µg/l)			
			Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
Groundwater receptors[9]	Surface water receptors[9]				Freshwater	Transitional (estuaries) and coastal waters
Hazardous substance	Priority substance	Pentachloro-phenol (PCP) (as a pesticide, but reported in an SVOC suite)	0.1[7]	0.1[2]	0.4[6a]	0.4[6a]
Petroleum hydrocarbons						
Hazardous substance	-	Total petroleum hydrocarbons	-	See Table 2 for individual (non-statutory) TPH CWG fractions with respect to drinking water receptors	See individual risk driving compounds (i.e. BTEX and PAH) for specific EQS	
Hazardous substance	Priority substance	Benzene (Aro EC5-EC7)	1[7]	1[2]	10[6a]	8[6a]
Hazardous substance	Specific pollutant	Toluene (Aro EC7-EC8)	4[7]	700[4]	74[6a]	74[6a]
Hazardous substance	-	Ethylbenzene (Aro EC8-EC10)	-	300[4]	300[11]	-
(Not determined)	-	Xylenes (Aro EC8-EC10)	3[7]	500[4]	30[11]	-
Non-hazardous pollutant	-	Methyl tertiary butyl ether (MTBE)	-	15[12]	-	

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Substance classification		Determinant	Target concentrations (µg/l)			
			Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
Groundwater receptors[3]	Surface water receptors[3]				Freshwater	Transitional (estuaries) and coastal waters
Pesticides, fungicides, insecticides and herbicides						
(Not determined) – assume to be Hazardous Substance	-	Total pesticides	-	0.5[2]	-	-
(Not determined) - assume to be Hazardous Substance	-	Other individual pesticides (unless otherwise detailed below)	-	0.1[2]	-	-
Hazardous substance(s)	Other pollutant (Cyclodiene pesticides)	Aldrin	0.003[7]	0.03[2]	0.01[6a] (sum of all four)	0.005[6a] (sum of all four)
		Dieldrin	0.003[7]	0.03[2]		
		Endrin	0.003[7]	0.1[2b] ('other individual pesticide')		
		Isodrin*2	0.003[7]	0.1[2b] ('other individual pesticide')		
Hazardous substance	Other pollutant	DDT (total)	0.002[7]	0.1[2] ('other individual pesticide')	0.025[5a]	0.025[5a]
Hazardous substance	Specific pollutant	Carbendazim	-	0.1[2] ('other individual pesticide')	0.15[6a]	-

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Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[3]	Surface water receptors[3]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters
Hazardous substance	Specific pollutant	Chlorothalonil	-	0.1[2] ('other individual pesticide')	0.035[5a]	-
Hazardous substance	Specific pollutant (until 22/12/18, after which it becomes a Priority substance)	Cypermethrin	-	0.1[2] ('other individual pesticide')	0.0001[5a] From 22/12/18: $8.0E^{-5}$[5a]	0.0001[5a] From 22/12/18: $8.0E^{-6}$[6a]
Hazardous substance	Specific pollutant	Dimethoate	0.01[7]	0.1[2] ('other individual pesticide')	0.48[6a]	0.48[6a]
(Not determined)	Specific pollutant	Glyphosate	-	0.1[2] ('other individual pesticide')	196[6a]	196[6a]
Hazardous substance	Specific pollutant	Linuron	-	0.1[2] ('other individual pesticide')	0.5[6a]	0.5[6a]
Non-hazardous pollutant	Specific pollutant	Mecoprop	0.04[7]	0.1[2] ('other individual pesticide')	18[6a]	18[6a]
Non-hazardous pollutant	Specific pollutant	Methiocarb	-	0.1[2] ('other individual pesticide')	0.01[6a]	-
Non-hazardous pollutant	Specific pollutant	Pendimethalin	-	0.1[2] ('other individual pesticide')	0.3[6a]	-

Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[1]	Surface water receptors[1]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters
Hazardous substance	Specific pollutant	Permethrin	0.001[7]	0.1[2] ('other individual pesticide')	0.001[5a]	0.0002[5a]
Hazardous substance	Priority substance	Alachlor	-	0.1[2] ('other individual pesticide')	0.3[6a]	0.3[6a]
Hazardous substance	Priority substance	Atrazine	0.03[7]	100[4] ('other individual pesticide')	0.6[6a]	0.6[6a]
Hazardous substance	Priority substance	Diuron	-	0.1[2] ('other individual pesticide')	0.2[6a]	0.2[6a]
Hazardous substance	**Priority hazardous substance**	Endosulphan	0.005[7]	0.1[2] ('other individual pesticide')	0.005[6a]	0.0005[6a]
Non-hazardous pollutant	Priority substance	Isoproturon	-	0.1[2] ('other individual pesticide')	0.3[6a]	0.3[6a]
Hazardous substance	Priority substance	Simazine	0.03[7]	0.1[2] ('other individual pesticide')	1[6a]	1[6a]
Hazardous substance	**Priority hazardous substance**	Trifluralin	0.01[7]	0.1[2] ('other individual pesticide')	0.03[6a]	0.03[6a]

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Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[3]	Surface water receptors[3]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters
(Not determined)	From 22/12/18: Priority substance	Dichlorvos	-	0.1[2] ('other individual pesticide')	From 22/12/18: $6.0E^{-4}$[6a]	From 22/12/18: $6.0E^{-5}$[6a]
Hazardous substance	From 22/12/18: Priority substance	Heptachlor and heptachlor epoxide	-	0.03[2]	From 22/12/18: $2.0E^{-7}$[6a]	From 22/12/18: $1.0E^{-08}$[6a]
Miscellaneous						
None	Specific pollutant	Triclosan (antibacterial agent)	-	-	0.1[6a]	0.1[6a]
Hazardous substance	**From 22/12/18: Priority hazardous substance**	Perfluoro-octane sulfonic acid (and its derivatives) (PFOS)	-	-	From 22/12/18: $6.5E^{-4}$[6a]	From 22/12/18: $1.3E^{-4}$[6a]
Hazardous substance	**From 22/12/18: Priority hazardous substance**	Hexabromo cyclododecane (HBCDD)	-	-	From 22/12/18: 0.0016[6a]	From 22/12/18: 0.0008[6a]

Substance classification		Determinant	Target concentrations (µg/l)			
Groundwater receptors[9]	Surface water receptors[9]		Minimum reporting value	UK drinking water standard (or best equivalent)	EQS or best equivalent	
					Freshwater	Transitional (estuaries) and coastal waters

Notes:

- A target concentration is not available.

[1] Please note that total ammonia (NH_4^+ and NH_3) is equivalent to ammoniacal nitrogen in laboratory reports.

[2] Please note that although iron is listed in the 2015 Direction as 1,000 µg/l, the EQS remains at 1mg/l in Scotland and it is assumed this is an error and should read either 1,000 or 1000µg/l.

[3] Please note that although Isodrin is not listed in name within the group of 'Cyclodiene pesticides' in Table 1 of Schedule 3 Part 3 of the 2015 Direction[10], the CAS number for Isodrin (465-73-6) is listed and therefore it is assumed that it has been missed off the named list of substances.

[4] Total petroleum hydrocarbons is used for consistency, but is an analytical method defined measurement for a mixture of hydrocarbons subject to environmental analysis[11].

'Bioavailable' in relation to copper, zinc, nickel and manganese (but not lead) is the generic EQSbioavailable[12] derived from the Metal Bioavailability Assessment Tool (M-BAT) developed by the Water Framework Directive UK Technical Advisory Group (WFDTAG). Exceedance of this value should prompt a site-specific assessment using the M-BAT with pH, DOC and Ca to derive a site-specific EQS termed the $PNEC_{bioavail}$.

http://www.wfduk.org/resources/rivers-lakes-metal-bioavailability-assessment-tool-m-bat.

For zinc, if there is an exceedance of the EQSbioavailable in an initial GQRA, Tier 2 required that the EQS for zinc should also have the ambient background concentration of zinc added as well.

Table 2: World Health Organization (WHO) guide values for TPH CWG fractions in drinking water[13] (as referenced in CL:AIRE, 2017[11])

TPH CWG fraction	WHO guide value for drinking water[13] (µg/l)
Aliphatic fractions:	
Aliphatic EC5-EC6	15,000
Aliphatic >EC6-EC8	15,000
Aliphatic >EC8-EC10	300
Aliphatic >EC10-EC12	300
Aliphatic >EC12-EC16	300
Aliphatic >EC16-EC21	-
Aliphatic >EC21-EC35	-
Aromatic fractions:	
Aromatic EC5-EC6	10 (benzene)
Aromatic >EC6-EC8	700 (toluene)
Aromatic >EC8-EC10	300 (ethyl benzene) 500 (xylenes)
Aromatic >EC10-EC12	90
Aromatic >EC12-EC16	90
Aromatic >EC16-EC21	90
Aromatic >EC21-EC35	90
Reference: World Health Organisation (WHO), 2008. Petroleum products in drinking-water. Background document for development of WHO guidelines for drinking water quality. WHO/SDE/WSH/05.08/123. World Health Organisation, Geneva[13].	

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References

1. Environment Agency (2017), 'The Environment Agency's approach to groundwater protection', version 1.0, March 2017 (formerly contained within GP3) [accessed 29 March 2017]. https://www.gov.uk/government/collections/groundwater-protection

1a. Environment Agency (2017), 'Land contamination groundwater compliance points: quantitative risk assessments', March 2017 (formerly contained within GP3) [accessed 29 March 2017]. https://www.gov.uk/government/collections/groundwater-protection

2. The Water Supply (Water Quality) Regulations 2016 (SI 2016/619)
    2a. Sum of chloroform, bromoform, dibromochloromethane and bromodichloromethane
    2b. Standard applies to individual pesticides except aldrin, dieldrin, heptachlor and heptachlor epoxide, for which a separate standard is defined.
3. The Private Water Supplies (England) Regulations 2016. SI 2016 / 618
4. WHO (2011), *Guidelines for drinking-water quality*, 4th edn
5. JAGDAG hazard substance determinations: This list contains substances that are determined to be hazardous substances or non-hazardous pollutants for the purposes of the groundwater directive 2006/118/EC. The absence of an assessment or substance from the list means an assessment has not been done yet and is presented as 'Not yet determined'; if a substance has been assessed but does not fall into either category it is presented as 'None'. For further details on how substances are assessed, see the Joint Agencies Groundwater Directive Advisory Group (JAGDAG) 'Methodology for the determination of hazardous substances in groundwater for the purposes of the groundwater directive 2006/118/EC' which is available from the JAGDAG website. The methodology is a UK –wide framework that sets criteria for how to assess whether a substance is a hazardous substances in groundwater. The list of substances can be found at:

   https://www.wfduk.org/stakeholders/jagdag

6. The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.
    6a. The EQS for these substances are based on a "long term mean" or an "annual average (AA)" EQS.
    6b. For cadmium and its compounds the EQS values vary depending on the hardness of the water as specified in five class categories (Class 1: < 40 mg CaCO3/l, Class 2: 40 to < 50 mg CaCO3/l, Class 3: 50 to < 100 mg CaCO3/l, Class 4: 100 to < 200 mg CaCO3/l and Class 5: ≥ 200 mg CaCO3/l).
    6c. The EQS for Mercury and hexachlorobutadiene are based on a "maximum acceptable concentration (MAC)" EQS in absence of an "annual average (AA)" EQS.
    6d. The EQS for chlorine in saltwater is based on the 95th percentile concentration of total residual oxidant, which refers to the sum of all oxidising agents existing in water, expressed as available chlorine.
    6e. The recommended saltwater standard is derived using a safety factor of 100. Where the standard is failed, it is recommended that supporting evidence of ecological damage should be obtained before committing to expensive action.
    6f. EQS for total ammonia is as per Schedule 3, Part 1, Table 7 of of the above directions. EQS applies to river types 1, 2 and 4 and 6 (namely upland and low alkalinity). The EQS for a lowland and high alkalinity rivers (types 3, 5 and 7) is 600µg/l (0.6mg/l).

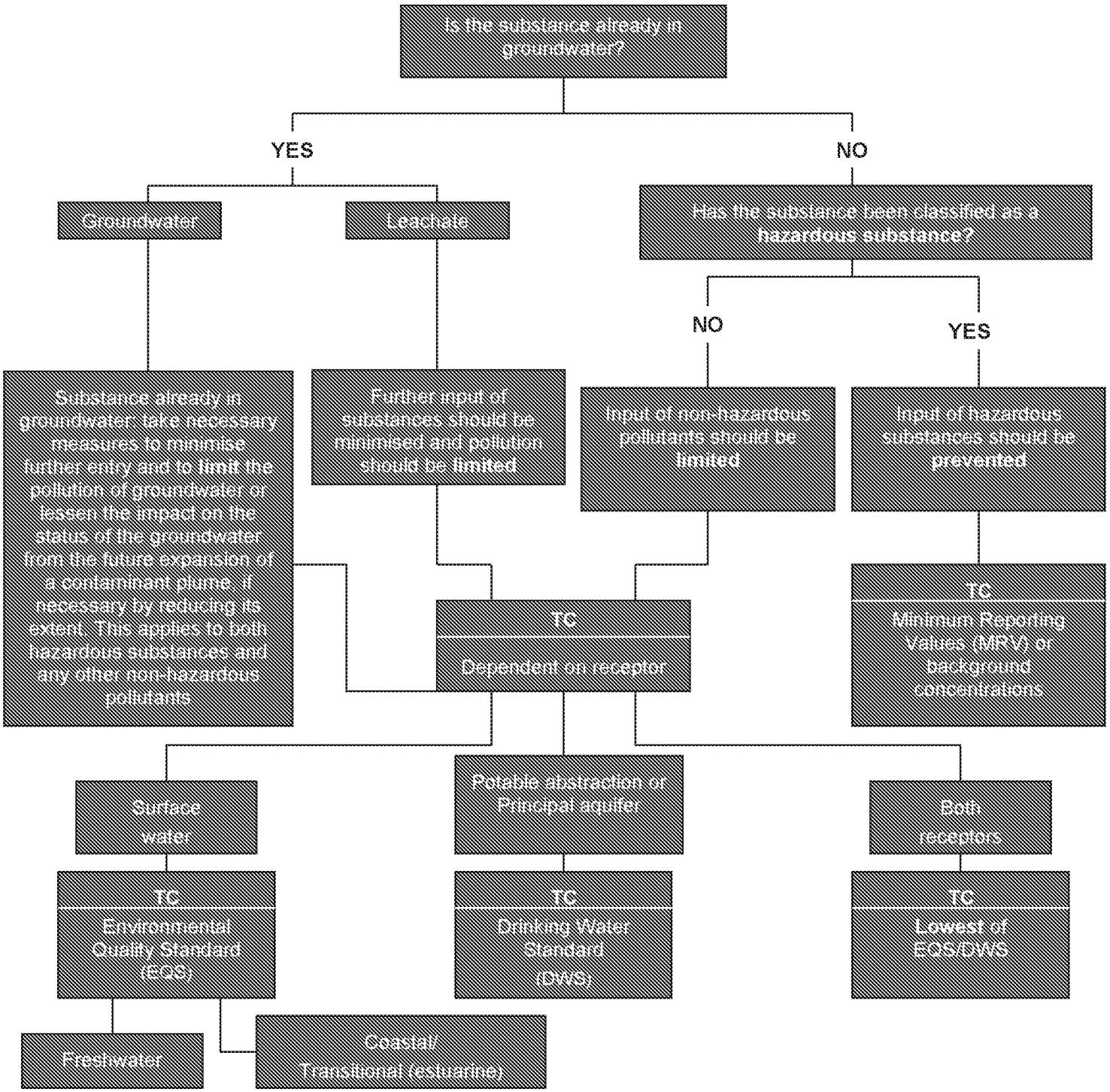
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Additional information on the Metal Bioavailability Assessment Tool (M-BAT) is available at http://www.wfduk.org/resources/rivers-lakes-metal-bioavailability-assessment-tool-m-bat

7. Minimum reporting values listed at https://www.gov.uk/government/publications/values-for-groundwater-risk-assessments/hazardous-substances-to-groundwater-minimum-reporting-values (updated 13 January 2017; accessed 29 March 2017). Note target concentration for xylenes is 3 µg/l each for o-xylene and m/p xylene as it may not be possible to separate m- and p-xylene; 135 tcb, 124 tcb, 123 tcb each to 0.01 µg/l)
8. The Surface Waters (Abstraction for Drinking Water) (Classification) Regulations 1996 (as amended). SI 1996 / 3001
9. Council Directive on the Quality of Fresh Waters Needing Protection or Improvement in Order to Support Fish Life (Freshwater Fish Directive) (78/659/EEC)
10. WRc plc (2002), R&D Technical Report P45.
11. CL:AIRE, 2017. Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies. V1.1.
12. Drinking Water Inspectorate (London, UK). Environmental Information Request on MTBE in drinking water. Ref. DWI 1/10/18; dated 28 November 2006. Value is based on the odour threshold for MTBE, which is lower than a health-based guideline value
13. World Health Organisation (WHO), 2008. Petroleum products in drinking-water. Background document for development of WHO guidelines for drinking water quality. WHO/SDE/WSH/05.08/123. World Health Organisation, Geneva. [accessed 29 March 2017] http://www.who.int/water_sanitation_health/dwq/chemicals/petroleumproducts_2add_june2008.pdf

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FLOW CHART TO ASSIST WITH SELECTION OF TARGET CONCENTRATIONS



TC = Target concentration

When leachate is being assessed the 'compliance point' is the groundwater body. Therefore dilution within the groundwater body may be applied with caution before comparing with the TC.

When directly assessing a receptor, e.g., a river, the appropriate TC should be selected.

Controlledwaters_GAC_Rev14 E&W

APPENDIX J
GENERIC ASSESSMENT CRITERIA FOR POTABLE WATER SUPPLY PIPES

A range of pipe materials is available and careful selection, design and installation is required to ensure that water supply pipes are satisfactorily installed and meet the requirements of the Water Supply (Water Fittings) Regulations 1999 in England and Wales, the Byelaws 2000 in Scotland and the Northern Ireland Water Regulations. The regulations include a requirement to use only suitable materials when laying water pipes and laying water pipes without protection is not permitted at contaminated sites. The water supply company has a statutory duty to enforce the regulations.

Contaminants in the ground can pose a risk to human health by permeating potable water supply pipes. To fulfil their statutory obligation, UK water supply companies require robust evidence from developers to demonstrate either that the ground in which new plastic supply pipes will be laid is free from specific contaminants, or that the proposed remedial strategy will mitigate any existing risk. If these requirements cannot be demonstrated to the satisfaction of the relevant water company, it becomes necessary to specify an alternative pipe material on the whole development or in specific zones.

In 2010, UK Water Industry Research (UKWIR) published *Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (Report Ref. No. 10/WM/03/21). This report reviewed previously published industry guidelines and threshold concentrations adopted by individual water supply companies.

The focus of the UKWIR research project was to develop clear and concise procedures, which provide consistency in the pipe selection decision process. It was intended to provide guidance that can be used to ensure compliance with current regulations and to prevent water supply pipe failing prematurely due to the presence of contamination.

The report concluded that in most circumstances only organic contaminants pose a potential risk to plastic pipe materials and Table 3.1 of the report provides threshold concentrations for polyethylene (PE) and polyvinyl chloride (PVC) pipes for the organic contaminants of concern. The report also makes recommendations for the procedures to be adopted in the design of site investigations and sampling strategies, and the assessment of data, to ensure that the ground through which water supply pipes will be laid is adequately characterised.

Risks to water supply pipes have therefore been assessed against the threshold concentrations for PE and PVC pipe specified in Table 3.1 of Report 10/WM/03/21, which have been adopted as the GAC for this linkage and are reproduced in Table A3 below.

Since water supply pipes are typically laid at a minimum depth of 0.75 m below finished ground levels, sample results from depths between 0.5 m and 1.5 m below finished level are generally considered suitable for assessing risks to water supply. Samples outside these depths can be used, providing the stratum is the same as that in which water supply pipes are likely to be located. The report specifies that sampling should characterise the ground conditions to a minimum of 0.5 m below the proposed depth of the pipe.

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It should be noted that the assessment provided in this report is a guide and the method of assessment and recommendations should be checked with the relevant water supply company.

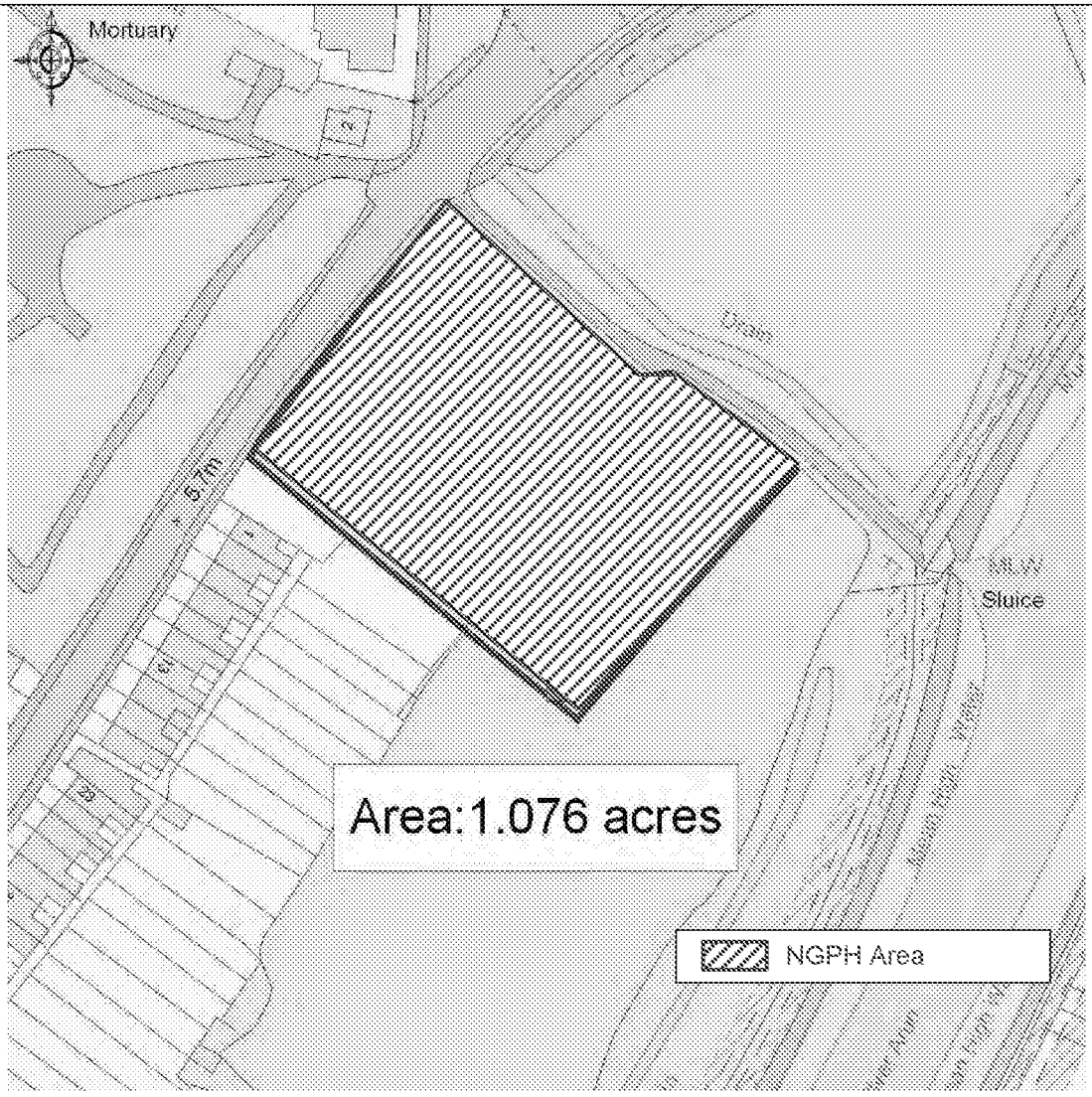
Table A3: Generic assessment criteria for water supply pipes

		Pipe material	
		GAC (mg/kg)	
	Parameter group	PE	PVC
1	Extended VOC suite by purge and trap or head space and GC-MS with TIC (Not including compounds within group 1a)	0.5	0.125
1a	• BTEX + MTBE	0.1	0.03
2	SVOCs TIC by purge and trap or head space and GC-MS with TIC (aliphatic and aromatic C_5–C_{10}) (Not including compounds within group 2e and 2f)	2	1.4
2e	• Phenols	2	0.4
2f	• Cresols and chlorinated phenols	2	0.04
3	Mineral oil C_{11}–C_{20}	10	Suitable
4	Mineral oil C_{21}–C_{40}	500	Suitable
5	Corrosive (conductivity, redox and pH)	Suitable	Suitable
Specific suite identified as relevant following site investigation			
2a	Ethers	0.5	1
2b	Nitrobenzene	0.5	0.4
2c	Ketones	0.5	0.02
2d	Aldehydes	0.5	0.02
6	Amines	Not suitable	Suitable
Notes: where indicated as 'suitable' the material is considered resistant to permeation or degradation and no threshold concentration has been specified by UKWIR.			

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APPENDIX K
PRVIOUS SITE INVESTIGATION REPORTS

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Site Address	**Ford Road, Arundel, West Sussex, BN18 9DX**	NGP Document Tracking code	
Report Title	**Ford Road, Arundel – Environmental Liability Assessment Report**		
Report Type	**Desk Study**	Retention Period	**Indefinitely**
Site Code	**2551**	Author (Company)	**Atkins**
Report Date	**April 1994**	Factual/Interpretative	**Factual**
Draft/Final	**Final**	H&S File?	**No**
Work Stage*	**Desk Study**		
Brief description of contents	**Desk Study**		
Access Permitted	**NGPH Land Regeneration Team**	NGPH Contact	**Sarah Helby**

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BRITISH GAS PROPERTIES **E5347/1994/APRIL**

ARUNDEL, FORD ROAD
(Ref SE12)
ENVIRONMENTAL LIABILITY
ASSESSMENT REPORT

WS Atkins Environment
Woodcote Grove
Ashley Road
Epsom
Surrey
[redacted]

ARUN DISTRICT COUNCIL AB/88/19/PL

Client:	British Gas Properties
Project:	British Gas Environmental Liability Assessment Report
Title:	Arundel, Ford Road (Ref SE12)
Job No:	E5347 ***Copy No:***
Document Reference:	E5347/LR860.NL/gp

0	Client Issue	N Legg	JE Steeds	DJ Nancarrow	JE Steeds		
							Client
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised (PM)	Date	
		WS Atkins					

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1 INTRODUCTION

Terms of Reference

1.1 WS Atkins was commissioned by British Gas Properties to undertake a desk study of possible ground contamination at Arundel, Ford Road (Ref SE12) resulting from the previous use of the site as a town gas manufacturing works. The boundary of the study site is WS Atkins interpretation of information supplied by British Gas. A definitive study site boundary was not available.



Methods and Information Sources

1.3 The study has been undertaken in general accordance with the guidance given in the British Standards Institution document DD175 (Reference 1), Appendix E of British Standards 5930 (Reference 2), Problems Arising from the Redevelopment of Gasworks (DoE 1988) (Reference 3) and the Technical Specification for Environmental Liability Assessments (PDU 1993) (Reference 4).

1.4 The sources of information used to carry out this assessment are given in Tables A.1 to A.3 (Appendix A). No historical site plans were available from British Gas for this site. The report of a former Desk Study (1983) was provided. This report included a brief summary of a report of a 1986 site investigation by the same company. British Gas could not identify any current or former employees with a knowledge of the operational history of the site.

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1.5 Information on potential contaminants associated with gas manufacturing and associated processes has been obtained from the following reference sources:

(i) Encyclopedia of Occupational Health and Safety, International Labour Organisation 1983;

(ii) Problems Arising form the Redevelopment of Gasworks and Similar Sites (2nd Edition), Department of the Environment, 1987.

Report Structure

1.6 The following sections of the report contain:

(i) a description of the site status at present, ie. current use and surface ground conditions;

(ii) a description of the site geology and hydrogeology;

(iii) a description of the site history ie. process activities, waste disposal and potential contaminants;

(iv) a summary of the findings of a previous site investigation;

[redacted]

[redacted]

[redacted]

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2 SITE LOCATION AND DESCRIPTION

2.1 The Ordnance Survey National Grid Reference No. is TQ014067 and the site covers an area of approximately one hectare (see Figure 1). Full details of the site are provided in Table 2.1 (site visit record sheet 1) and on Figure 2.

2.2 The site is located adjacent to the north west bank of the River Arun, Ford Road and Old Forge Mews.

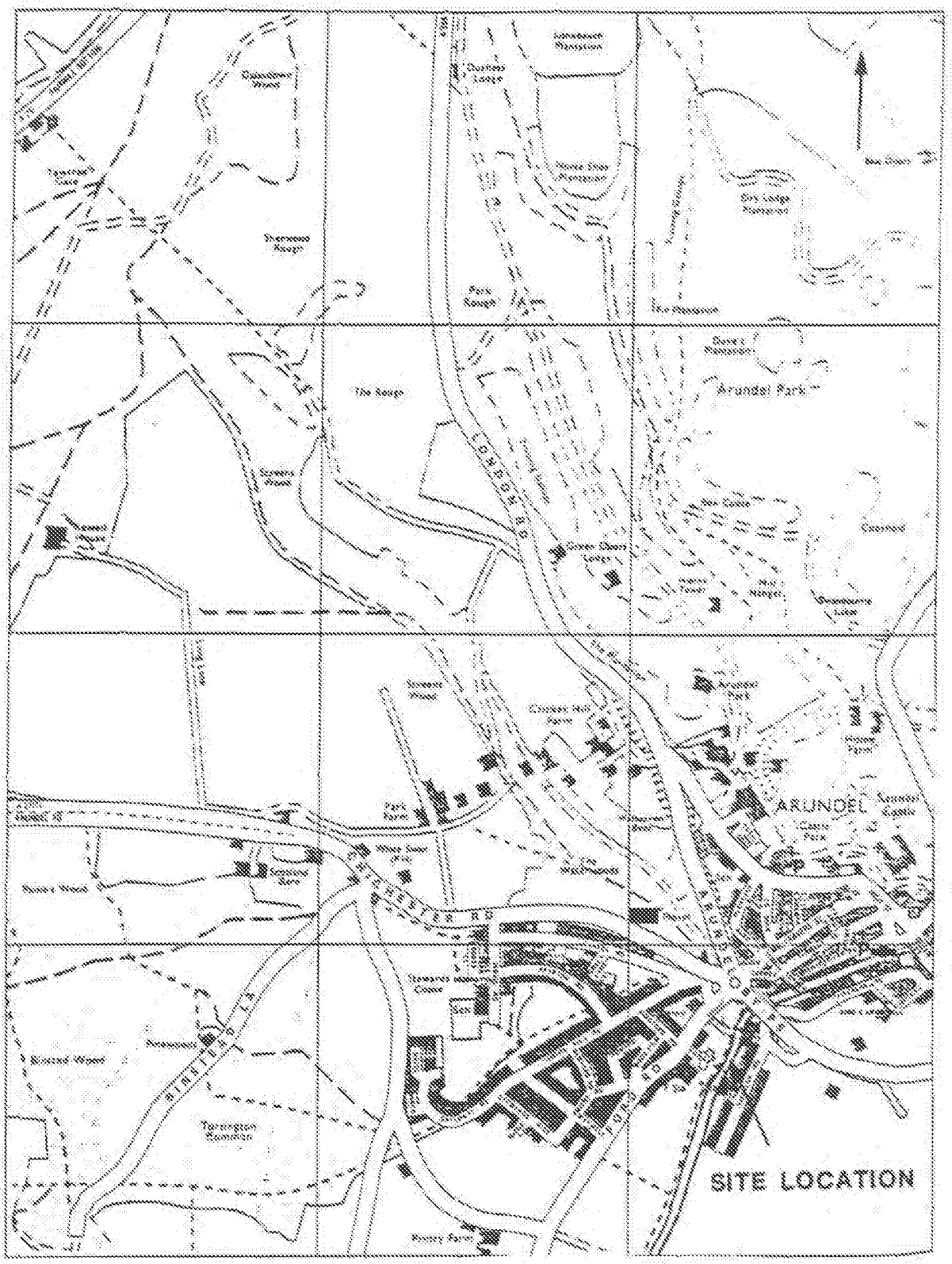
Table 2.1 : Site Visit Record Sheet I

Site Name: Arundel, Ford Road (Ref SE12) Date of Visit: 24 March 1994
Visited by: Nicola Legg

SUBJECT	INFORMATION
Current site size and uses	The site occupies an area of approximately one hectare. Approximately 60% is a grass field which is let for grazing (by horses). The remainder is classed as operational as the pressure monitor is checked once a week.
Description of ground cover, % of hard standing, (gravel/concentration/tarmac), condition of ground, % infiltration of precipitation	Approximately 60% is grassed, 5% has a tarmac surface and the remainder has a gravel surface. [redacted] Much of the site was waterlogged on the day of the site visit.
Location and type of surface drainage,(culverts, streams, rivers, ponds), approximate water level relative to ground surface	Drainage ditches along NE and SE boundaries. Any direct drainage connections from the site to these ditches was not visible. Any manholes observed during the walk-over survey are shown on the Figure 2.
Location and type of bunds, pits, walls. State of repair.	The bund along the river appeared in good condition but anecdotal evidence suggests the land on either side of the river (including the study site) floods frequently. Retaining walls along Ford Road and between the site and houses to the west both appeared to be in good condition.

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SUBJECT	INFORMATION
Adjacent land uses	West: houses with gardens. Northwest: cemetery beyond Ford Road. North east: field (appeared not to be grazed). East and south-east: River Arun separated from site by narrow stretch of waterlogged land, ditch and bund. South west: new houses.
Name of adjacent roads/rivers/canals	Ford Road, Old Forge Mews, River Arun.
Level of ground in relation to adjacent areas and other parts of site	The site itself is generally flat. It is set into the side of a gently sloping hill and the surrounding land slopes down from north west to south east. The houses to the west are at a higher level than the site although the lower parts of their gardens are at a similar level. The houses to the south west are at a similar level to the site.
Access to site boundaries	Access to the site boundary around the north arm of the site is slightly restricted by chain link security fencing which is positioned approximately 1m in from a wooden boundary fence. Access to all boundaries in the southern grassed half is unrestricted.
Visibly contaminated areas	Rubble (including concrete and old tarmac) was present on the operational area of site. Some iridescence on standing water and mud outside the site entrance was evident [redacted]
Visible evidence of foundations	Broken out old governor tank in north east corner. Concrete slab (tank base) in south east corner.
Present day potentially contaminative activities	Small electricity substation near north-east boundary.



Scale of Map is 2½ inches to 1 mile (1 : 25000)

0 1 Mile

0 500m 1 Kilometre

Title

Arundel, Ford Road (Ref SE12)
Site Location

WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road. Tel. (0372) 726140
Epsom, Surrey, KT18 5BW Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
18/2/94	KM	N.H.	IES	N/A	Figure 1	E5347

3 GEOLOGY AND GROUND CONDITIONS

Geology

3.1 The general geology in the vicinity of the site is shown on the British Geological Survey (BGS) 1:625,000 scale geological map No. 2. Other information was obtained from BGS Well Records Nos 21 and 88.

3.2 The solid geology of the study site is chalk overlain by sandy silty clay alluvium associated with the River Arun. The BGS borehole records indicate depths of alluvial material of 19m and 24m some 200m to the north east of the site. However, a site investigation by Harrison and Company of Thornton Heath in 1988 (see Chapter 5) indicated that less than 5m of alluvial material overlay the chalk (assuming the trial pits did not extend beyond 5m). Both BGS borehole records indicate the presence of groundwater in the Alluvium at approximately 2m depth. [redacted]

Hydrogeology

3.3 An NRA groundwater vulnerability map is not yet available for this area and similarly NRA Source Protection Zones are not yet completed for the region. The Southern Region's Appendix to the NRA's Policy and Practice for the Protection of Groundwater (Ref 6) indicates that under the former Southern Region Aquifer Protection Policy, the chalk is classified as Zone 1 in this area. [redacted] The NRA have no records of any significant pollution incidents associated with the site.

3.4 [redacted] A total of four groundwater abstractions are located within 2km of the study site. These are shown in Table 3.1. [redacted]

Hydrology

3.5 The NRA indicated that the tidal stretch of the River Arun adjacent to the site is classed as Estuary Class A (Good Quality) based on an assessment of biological, aesthetic and water quality.

3.6 The NRA have no records of any licensed abstractions from the River Arun itself within 2km of the study site. However, their records indicate that there are four abstractions within that distance from other smaller watercourses that are part of its catchment. These abstractions are also shown in Table 3.1.

Table 3.1 : Water Abstraction Data

Grid No.	Details	Source	Annual Quantity Abstracted (m^3)
TQ 00250526	Private water undertaking	Chalk	4550.0
TQ 01870794	Wild Fowl and Wetlands Trust	Chalk	1991148.0
TQ 00890742	Fish Farm	Chalk	318220.0
TQ 01800778	Public water supply	Chalk	1647000.0
TQ 0126 0533	Spray irrigation	Surface	13636.2
TQ 99460563	Spray irrigation	Surface	2500.0
TQ 02250503	Fish Farm	Surface	332000.0
TQ 01510567	Spray irrigation	Surface	24999.7

4 SITE HISTORY AND POTENTIAL CONTAMINANTS

Site History

Introduction

4.1 The site history has been assessed using all available plans, records and anecdotal information (see Appendix A). Relevant Ordnance Survey maps are given in Appendix B and anecdotal information is given in Appendix C. The information has been summarized in Table 4.1 and Figure 3. All processes and activities which are likely to have, or are known to have, resulted in contamination have been included in Table 4.1. Each feature described in Table 4.1 is given a reference number which can be used to identify it on Figure 3. The history of adjacent land uses is presented in a similar manner in Table 4.2.

Information from Statutory Authorities

4.2 The Environment, Tourism and Leisure Department of Arun District Council have limited records of a landfilling operation in the area immediately to the south west of the study site. This was essentially infilling of the former baths in the 1950s and 1960s. Materials used included bottles, timber, ash and pottery. The Council's records do not state the exact depth or volumes of wastes involved but it is believed that the maximum depth of waste is approximately 3.0m. This area and the land further south west (the site of Tortington Ironworks between 1899 and the early 1960s) has since been developed for 40 houses with gardens. The Council stated that a site investigation was carried out prior to development. At total of 500m^3 of topsoil was removed owing to the presence of copper, nickel, lead and zinc. he site investigation report concluded that there was "no major contamination threat".

4.3 West Sussex County Council Trading Standards Department have stated that a closed landfill site ("Canada Road Tip") is located within 250m of the site, to the north west. The landfill predates licensing regulations and the Council have no records of the depth or volume of waste involved. They believe, however, that the landfill received household waste and that tipping ceased in 1973 at the latest.

4.5 [redacted]

4.6 [redacted]

4.7 [redacted]

Table 4.1 : Historical Data Summary Sheet : Site Uses

Ref	Use/Feature	1875 OS	1899 OS	1912 OS	1914 OS	1933 OS	1937 OS	1946 OS	1961 OS	1971 OS	1994 SVI
1	Gasholder	North east of operational area	x	x	x	x	x	x	x	x	x
2	Drainage ditch	Through north of site and along western boundary	_	_	_	_	x	x	x	x	x
3	Buildings	South-western corner of site	_	_	_	_	_	_	_	_	x
4	Small circular structure (tank?)	North corner of operational area	x	x	x	x	x	x	x	x	x
5	Buildings	Operational area	_	_	_	_	_	Only two in north corner remained	_	x	x
6	Gasholder	*	North west corner of operational area							x	x
7	Gasholder		North of operational area						x	x	x
8	Small circular structure (tank?)	*	*	North east of operational area	?	?	_	?	?	x	x
9	Gasholder	*	*	*	*	*	Centre of site				x
10	Electricity sub station	*	*	*	*	*	*	*	*	North-east boundary	
11	Above ground tank	*	*	*	*	*	*	*	*	North-east boundary	Concrete base remaining
12	Valve pits	*	*	*	*	*	*	*	*	Centre of site	
13	Toilet	*	*	*	*	*	*	*	*	North-east boundary	

KEY	
?	Plan does not show this area or does not provide information
	Feature still present
x	Feature demolished/no longer present
OS	Ordnance Survey Map
BGP	British Gas Plan
AI	Anecdotal information from ex-employee
SVI	Site visit information
*	Feature not present

Notes:

1. Shaded features indicate areas of higher contaminative potential.
2. Waste disposal activities may have occurred throughout the site especially during its early history.

Table 4.2 : Historical Data Summary Sheet : Adjacent Site Uses

Boundary	1875 OS	1899 OS	1912 OS	1914 OS	1933 OS	1937 OS	1946 OS	1961 OS	1971 OS	1994 SVI
North west	Greenfield	Cemetery beyond road	_	_	_	_	_	_	_	_
North east	Drainage ditch with greenfield beyond	_	_	_	_	_	_	_	_	_
South east	Drainage ditch with River Arun beyond	_	_	_	_	_	_	_	_	_
South west	Baths and "Works"	Baths, iron works and sewage works	_	_	_	_	Ironworks buildings labelled as "works"	_	Agricultural engineering works, boat builders, sewage works and fire station	New housing estate
West	Greenfield	Terraced houses with gardens	_	_	_	_	_	_	_	_

KEY	
?	Plan does not show this area or does not provide information
_	Feature still present
x	Feature demolished/no longer present
OS	Ordnance Survey Map
BGP	British Gas Plan
AI	Anecdotal information from ex-employee
SVI	Site visit information
*	Feature not present

1. [redacted]
2. The baths on the perimeter of the south-western boundary were infilled in the 1950s and 1960s (see paragraph
3. A closed landfill is situated within 250m of the north-west boundary of the site (see paragraph 4.3).



[redacted]

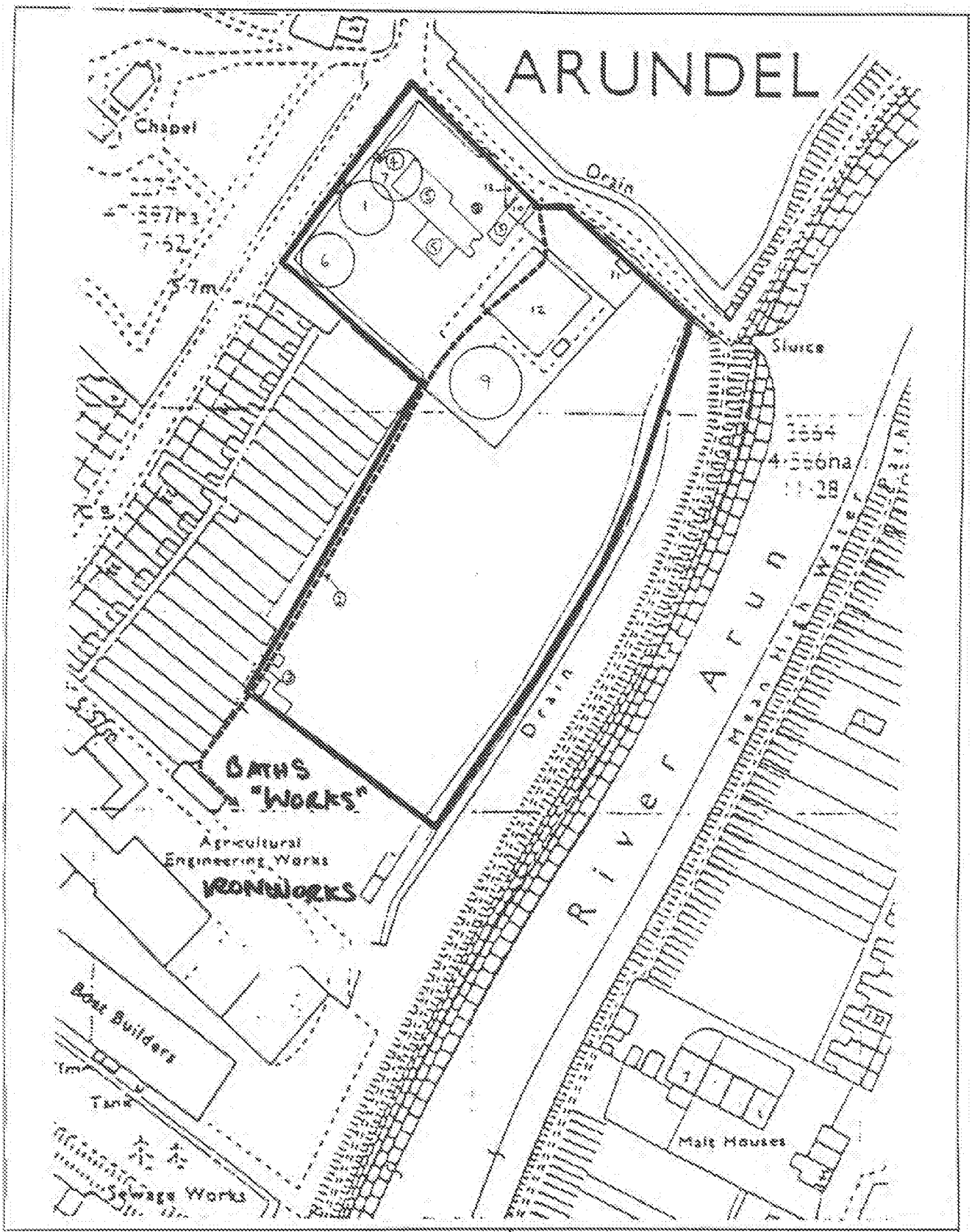
[redacted]

[redacted]

[redacted]

[redacted]





Title: Arundel, Ford Road (Ref SE12) Previous Process Activity Locations					WS Atkins Environment a division of WS Atkins Consultants Ltd. Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW Tel. (0372) 726140 Fax. (0372) 740055	
Date: 13/4/94	Drawn: NL	Checked: ES	Approved: JES	Scale: NTS	Drawing Number: Figure 8	Reference: E5347

E5347/LR860.NL/gp

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5 SITE INVESTIGATION DATA

Introduction

5.1 An investigation of the study site was carried out by Harrison and Company of Thornton Heath in 1988. The investigation comprised excavation of 22 trial pits to assess the contamination on the site. The original site investigation report was not available. The information given below is from a summary of the original report given in a desk study report produced by the same company in 1993.

Ground Conditions

5.2 In the north half of the site up to 3.0m (average 1.3m) of made ground was encountered. The nature of fill materials is not given in the summary. Buried structures including concrete, pipes and metal were found in this area.

[redacted]

5.4 Groundwater was not mentioned in the summary. Similarly there was no mention of visual or olfactory evidence of contamination.

[redacted]

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[redacted]

[redacted]

6.1 [redacted]

[redacted]

6.2 [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

6.8 [redacted]

[redacted]

[redacted]

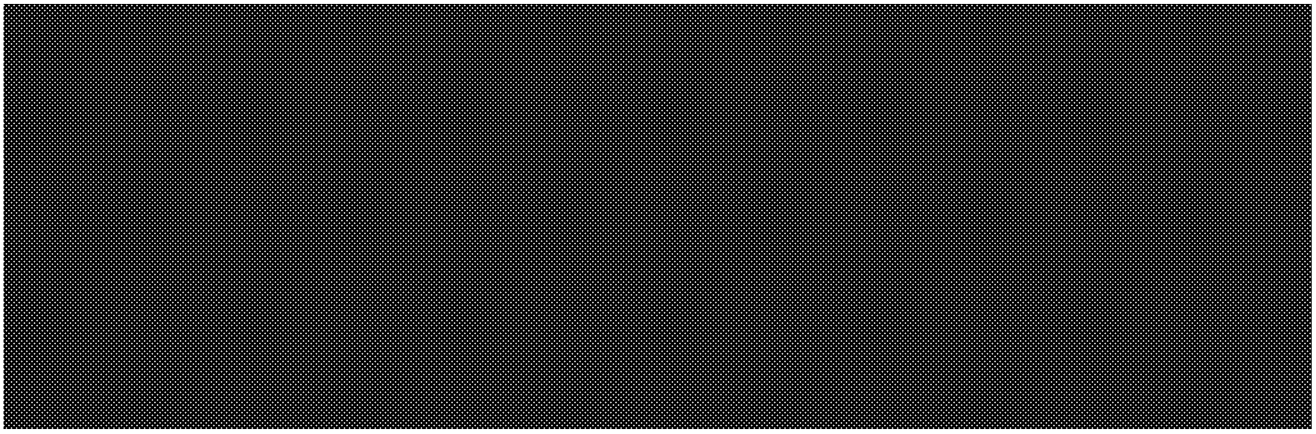
ARUN DISTRICT COUNCIL AB/88/19/PL

[redacted]

[redacted]

[redacted]etation.







ARUN DISTRICT COUNCIL AB/88/19/PL





6.19 [redacted]

ARUN DISTRICT COUNCIL AB/88/19/PL

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

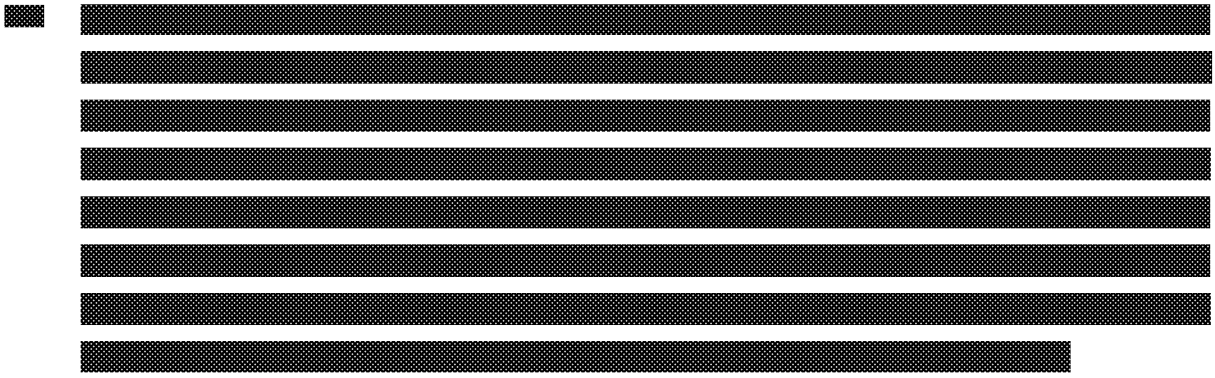
ARUN DISTRICT COUNCIL AB/88/19/PL



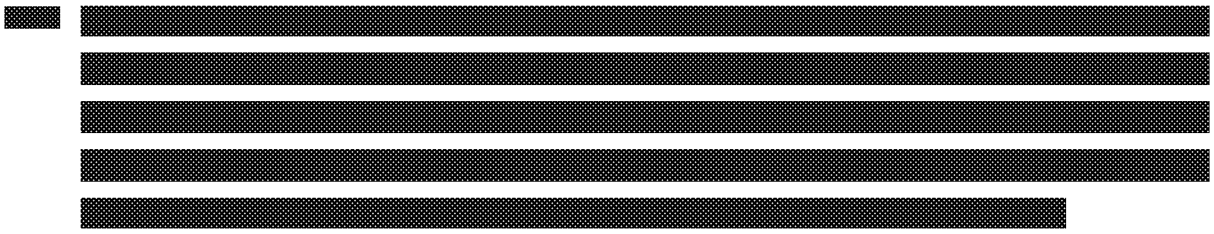














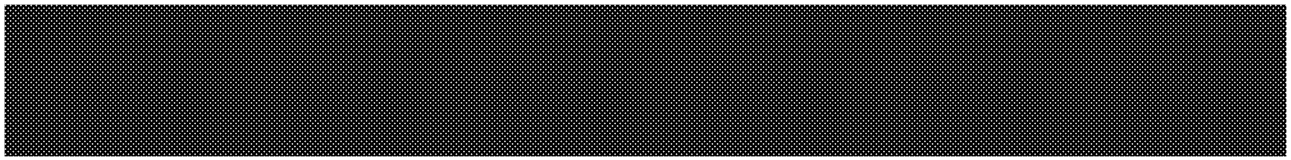


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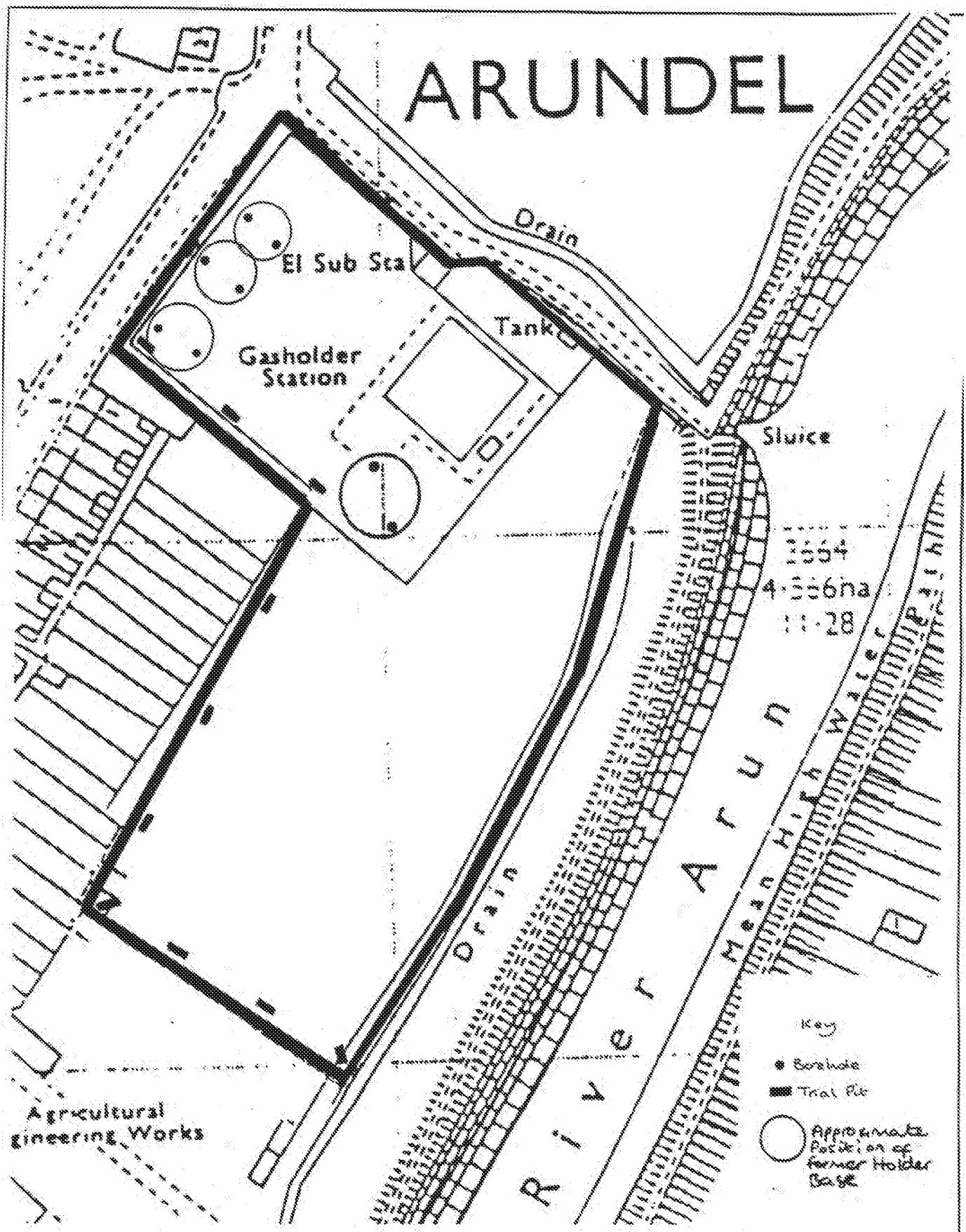


ARUN DISTRICT COUNCIL AB/88/19/PL









Title

Arundel, Ford Road (Ref SE12)
Proposed Site Investigation Locations for Statutory Purposes

WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road.
Epsom, Surrey, KT18 5BW
Tel. (0372) 726140
Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
13/4/94	NL	ES	JES	NTS	Figure 4	E5347

REFERENCES

1. BSI Draft for Development. Code of Practice for the Identification of Potentially Contaminated Land and its Investigation. DD175 (1988), British Standards Institution.

2. British Standard 5930. Code of Practice for Site Investigation (Appendix E) 1981.

3. Problems Arising from the Redevelopment of Gasworks and Similar Sites. Department of the Environment, 1987.

4. Technical Specification for Environmental Liability Assessments of Development Sites. British Gas plc (PDU) 1993.

5. Policy and Practice for the Protection of Groundwater. National Rivers Authority 1992.

6. Policy and Practice for the Protection of Groundwater. Regional Appendix Southern Region. National Rivers Authority 1993.

APPENDIX A

INFORMATION SOURCES

Table A.1 : British Gas Interpretative Reports
Information Sources Summary Sheet

Study Site Name: Arundel, Ford Road (Ref SE12)

Type	Source	Data Sought (Date)	Data Obtained/ Copied (Date)
Ordnance Survey Maps			
	West Sussex Records Office Chichester	7/3/94	11/3/94
British Gas Archive Plans			
	British Gas North Thames 2nd Floor Elizabeth House c/o North Thames House London Road Staines Middlesex TW18 4AE	25/2/94	None available
	The London Gas Museum British Gas Plc (North Thames) Twelve Trees Crescent Bromley-by-Bow London E3 3JH	6/4/94	None available
Service Plans			
Gas	Regional Wayleave Officer British Gas South-Eastern Regional Headquarters Croydon Surrey	14/3/94	16/3/94
Electricity	The Drawing Office Southern Electric Lower Drayton Lane Cosham Portsmouth Hampshire PO6 2HF	14/3/94	7/3/94
Water Supply	Development Services	21/3/94	25/3/94

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Type	Source	Data Sought (Date)	Data Obtained/ Copied (Date)
	Southern Water Ltd Southern House Lewes Road Falmer Brighton BM9 9PI		
Sewer	Development Services Southern Water Ltd Southern House Lewes Road Falmer Brighton BM9 9PI	21/3/94	25/3/94
BT	BT Tunbridge Wells Kent	14/3/94	28/3/94
Mercury Communications	Utilities Manager Mercury Communications Mercury House Waterside Park Langshotts Lane Bracknell, Berkshire	14/3/94	21/3/94
NRA Information			
	Pollution Control Officer NRA Sussex Region Rivers House 3 Liverpool Gardens Worthing West Sussex	21/3/94	20/4/94
Pre-1974 waste disposal information, contamination and pollution information	Mr J Green Environmental Health Department Arun District Council Civic Centre Maltravers Road Littlehampton West Sussex	21/3/94	30/3/94
	Matthew Thompson Waste Regulation Department Trading Department West Sussex County Council The Tannery Westgate, Chichester	21/3/94	31/3/94

Type	Source	Data Sought (Date)	Data Obtained/ Copied (Date)
Geological information	British Geological Survey	24/3/94	27/3/94
Hydrogeological information	British Geological Survey - Hydrology Group	24/3/94	27/3/94
Site investigation data	British Gas North Thames 2nd Floor Elizabeth House c/o North Thames House London Road Staines Middlesex TW18 4AE	25/2/94	16/3/94
Anecdotal information from present or ex-employees (see Site Visit Record Sheet II)	Name: None available Position: Dates of employment:		

Table A.2 : Library Visit Record Sheet

Study Site Name: Arundel, Ford Road (Ref SE12)

Date: 11/3/94

Library Name: West Sussex Records Office

Signature: Kika Mitchell

Chichester

Date	Edition	Scale	Ref No.	Copied
1875	-		LX III/1	_
1899	-		LX III/NW	_
1912	-		LX III/1	_
1914	-		LX III NW	_
1933	-		LX III/NW	_
1937	-		LX III/1	_
1938	Rev of 1909-10		LX III/NW	_
1946	Rev of 1909-10		LX III/NW	_
1961	-		TQ 100/NW	_

1971	-		TQ 0006/0106	--

Table A.3 : Archive Visit Record Sheet

Study Site Name: Arundel, Ford Road (Ref SE12) Date: March 1994

Archive Name:

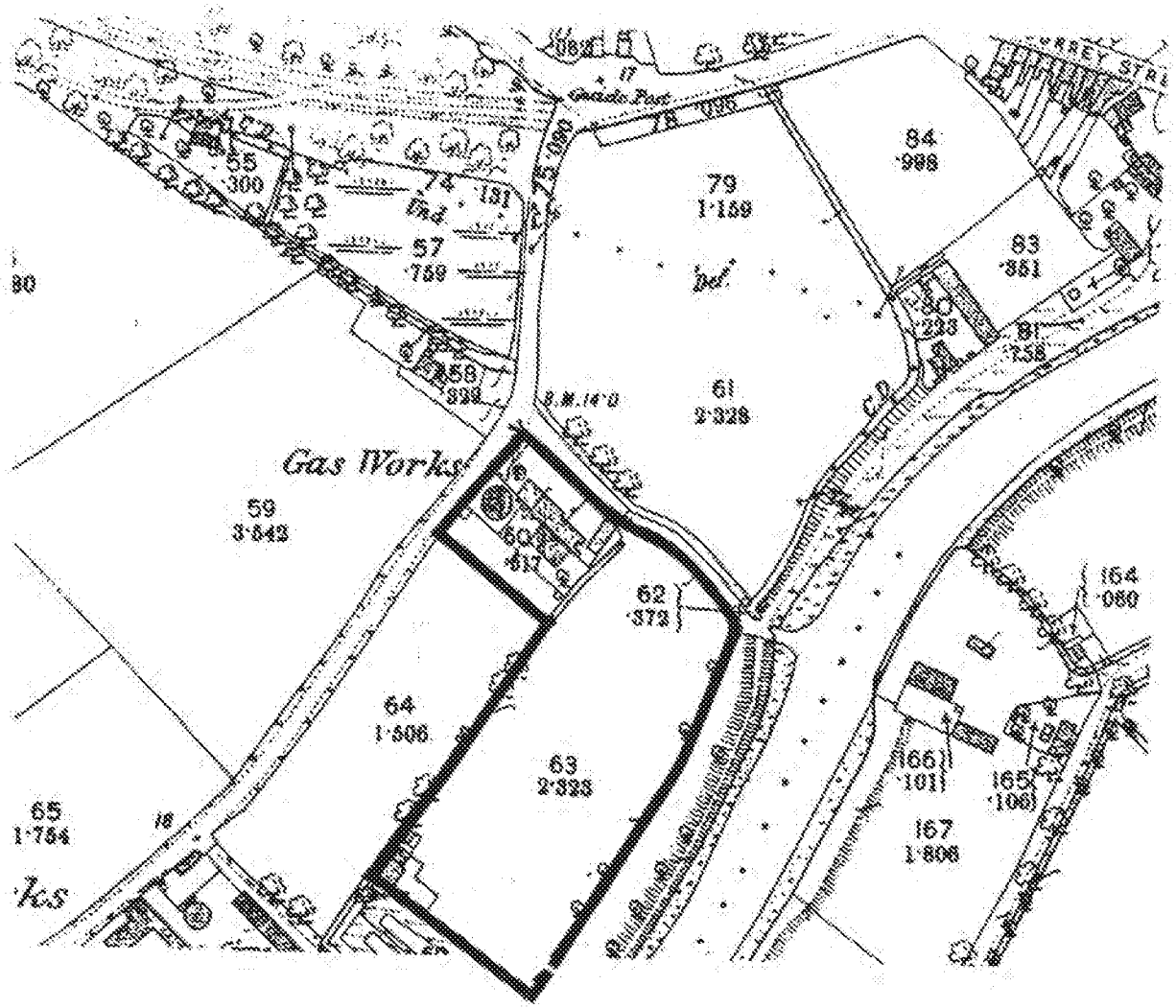
Contact Name: John Beer

Plan/Record	Title	Date	Ref No.	Copied
Plan	Arundel Holder Station - mains layout	July 1976	DE/SX/4/200	--
Report	Desk study on a disused gasworks at Ford Road, Arundel	July 1993	C604A	--

ARUN DISTRICT COUNCIL AB/88/19/PL

APPENDIX B

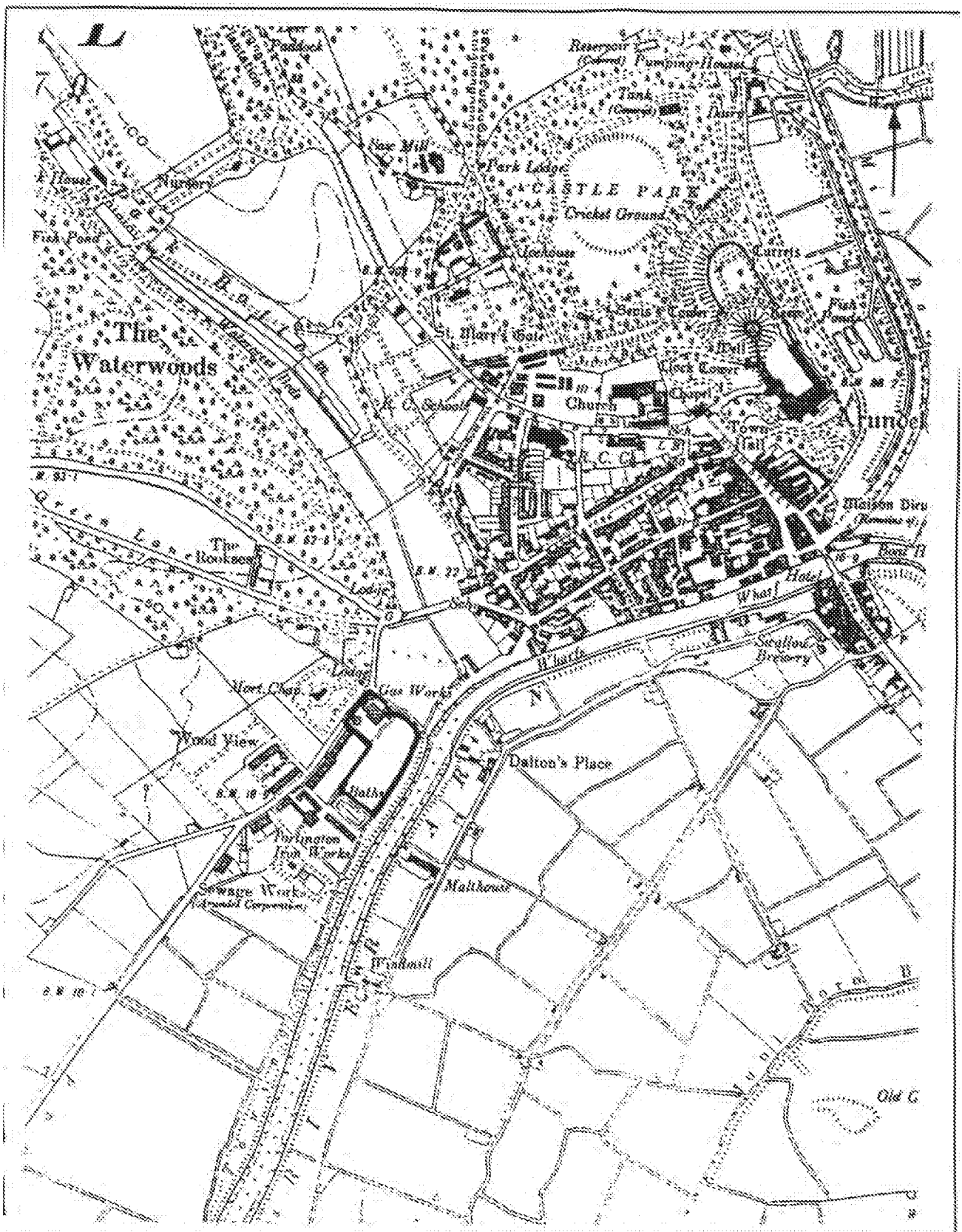
Ordnance Survey Maps



Title
Arundel, Ford Road (Ref SE12)
1875 Ordnance Survey Map

WS Atkins Environment
a division of WS Atkins Consultants Ltd.
Woodcote Grove, Ashley Road. Tel. (0372) 726140
Epsom, Surrey. KT18 5BW Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
30/08/94	MM	N.H.	IBS	1:2500	R.1	E5347



Title

Arundel, Ford Road (Ref SE12)
1899 Ordnance Survey Map

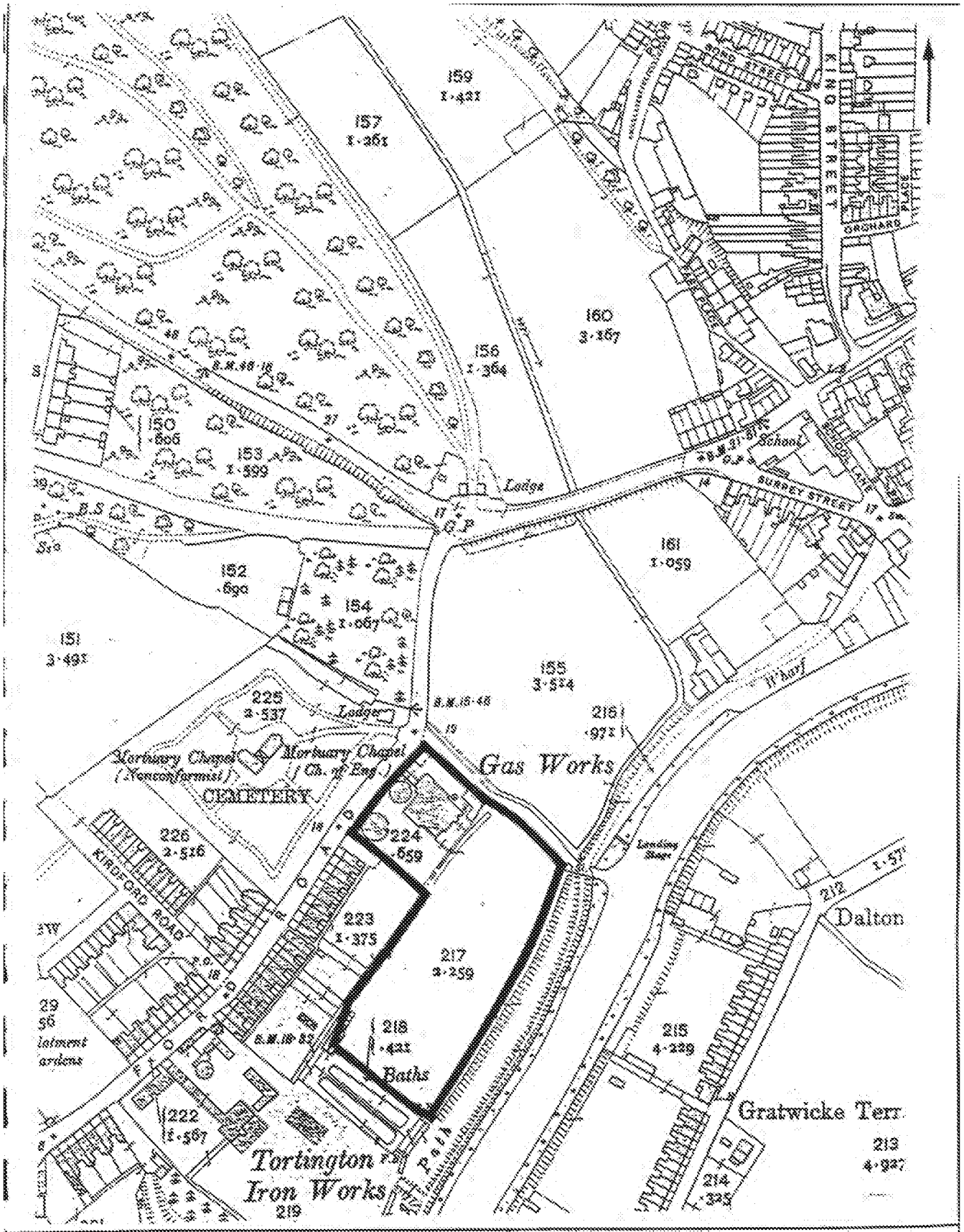
WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road
Epsom, Surrey, KT18 5BW

Tel. (0372) 726140
Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
23/3/94	KM	NJL	JES	NTS	B.2	E5347

ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp



Title

Arundel, Ford Road (Ref SE12)
1912 Ordnance Survey Map

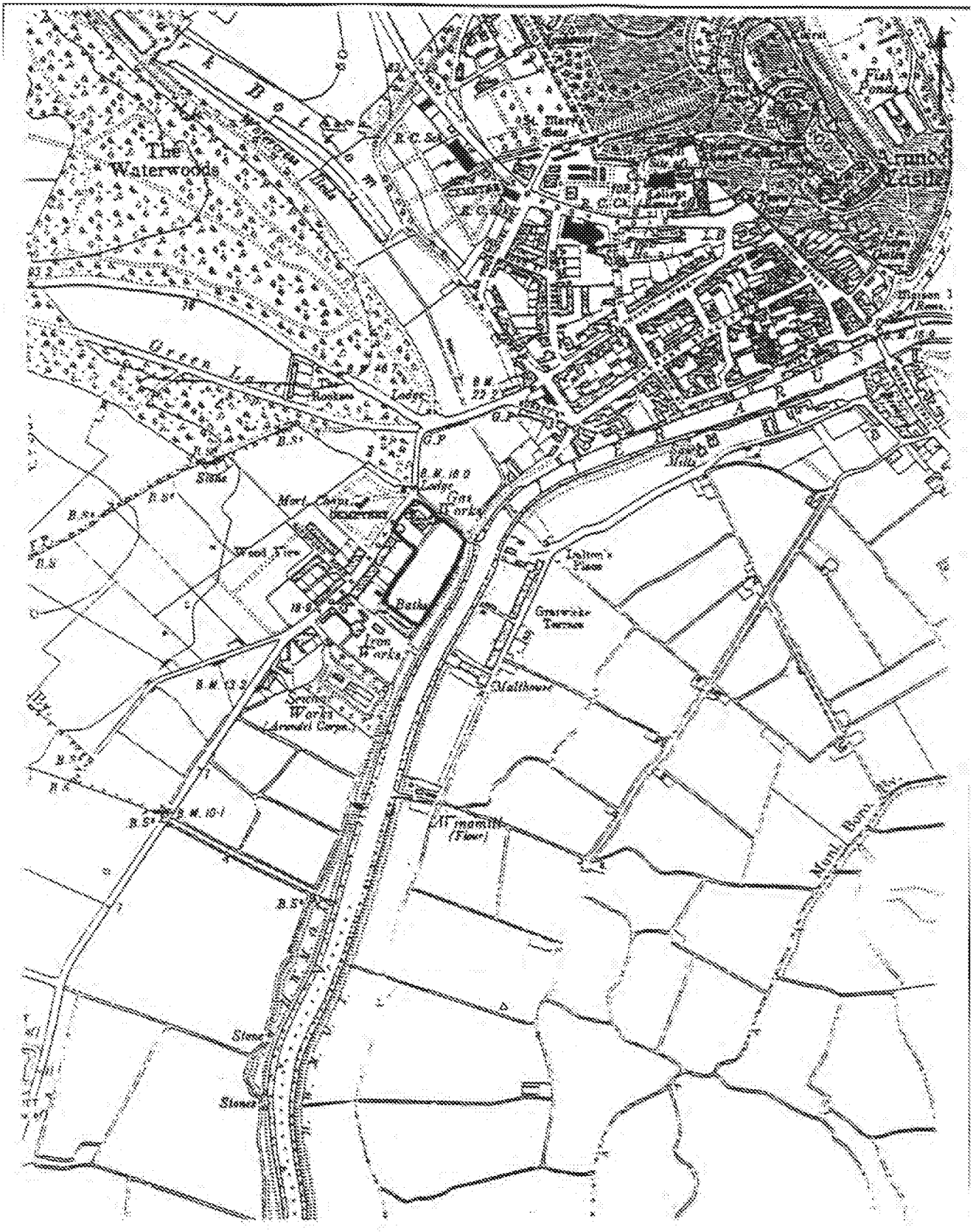
WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road.
Epsom, Surrey. KT18 5BW

Tel. (0372) 726140
Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
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ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp



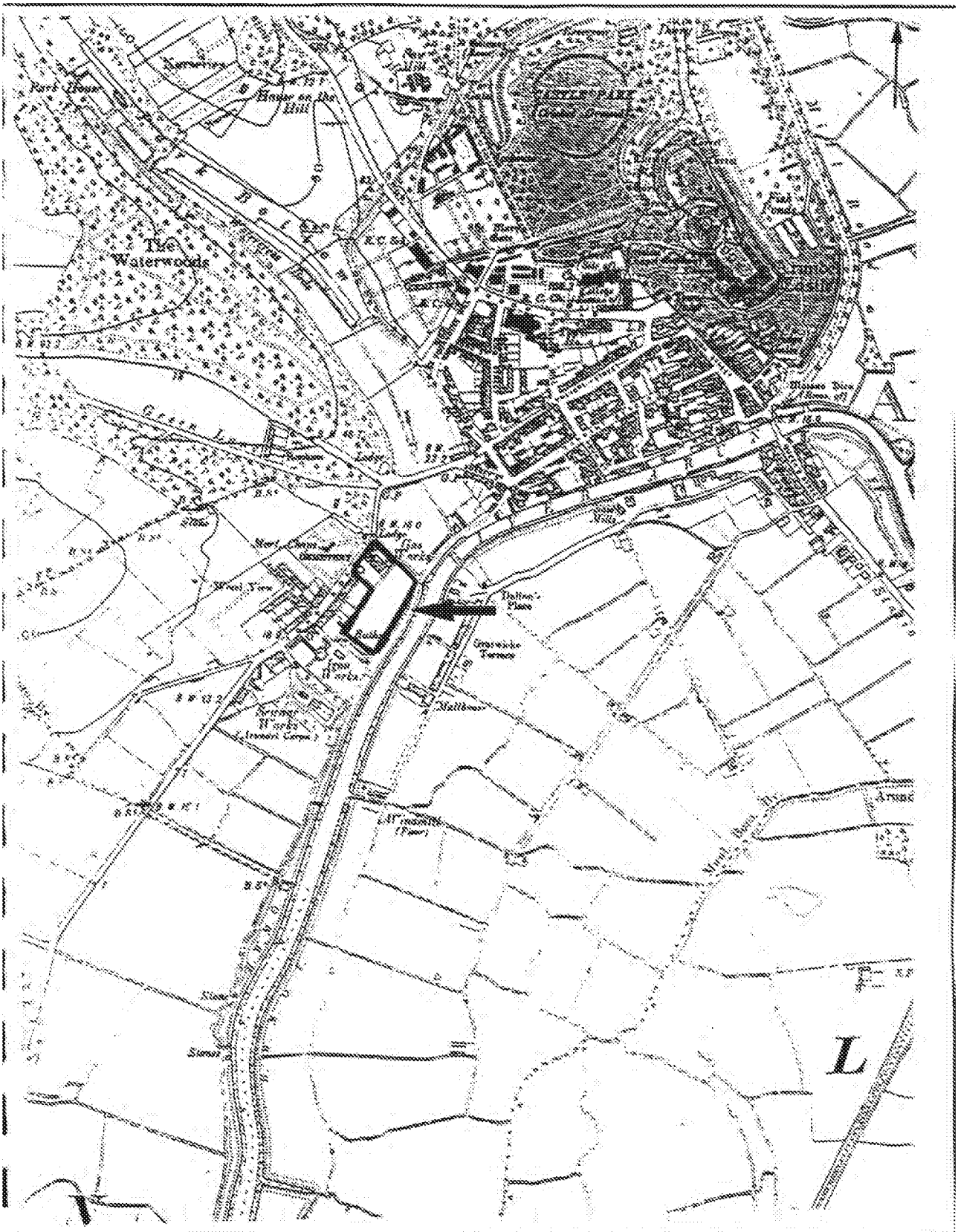
Title

Arundel, Ford Road (Ref SE12)
1914 Ordnance Survey Map

WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road. Tel. (0372) 726140
Epsom, Surrey. KT18 5BW Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
23/3/94	KM	NJL	JES	NTS	B. 4	E5347



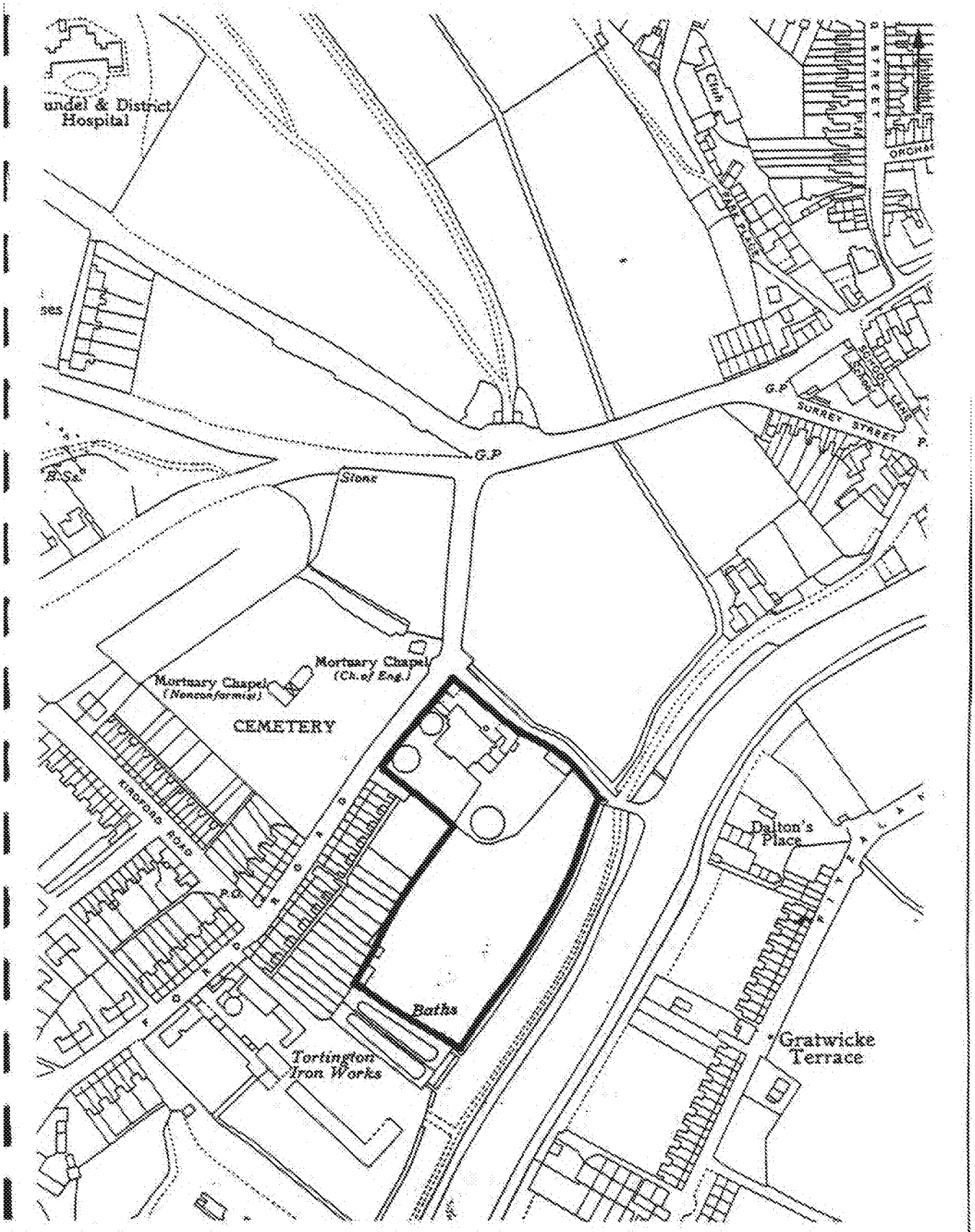
Title
Arundel, Ford Road (Ref SE12)
1933 Ordnance Survey Map

WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road. Tel. (0372) 726140
Epsom, Surrey. KT18 5BW Fax. (0372) 740055

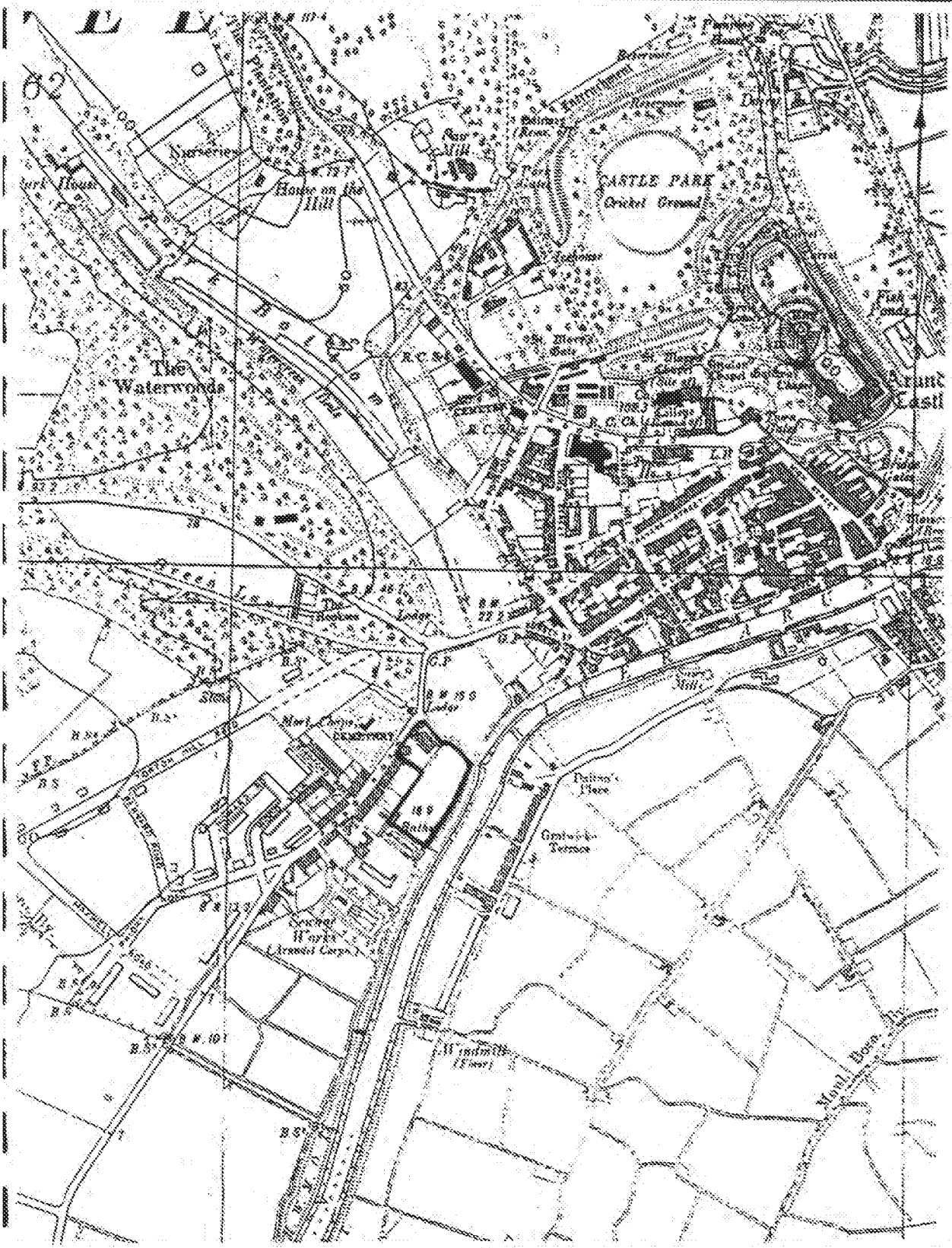
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ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp



Title: Arundel, Ford Road (Ref SE12) 1937 Ordnance Survey Map					WS Atkins Environment a division of WS Atkins Consultants Ltd. Woodcote Grove, Ashley Road. Epsom, Surrey. KT18 5BW Tel. (0372) 726140 Fax. (0372) 740055	
Date 23/3/94	Drawn KM	Checked N.H	Approved JFS	Scale 1:2500	Drawing Number B.6	Reference E5347

ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp



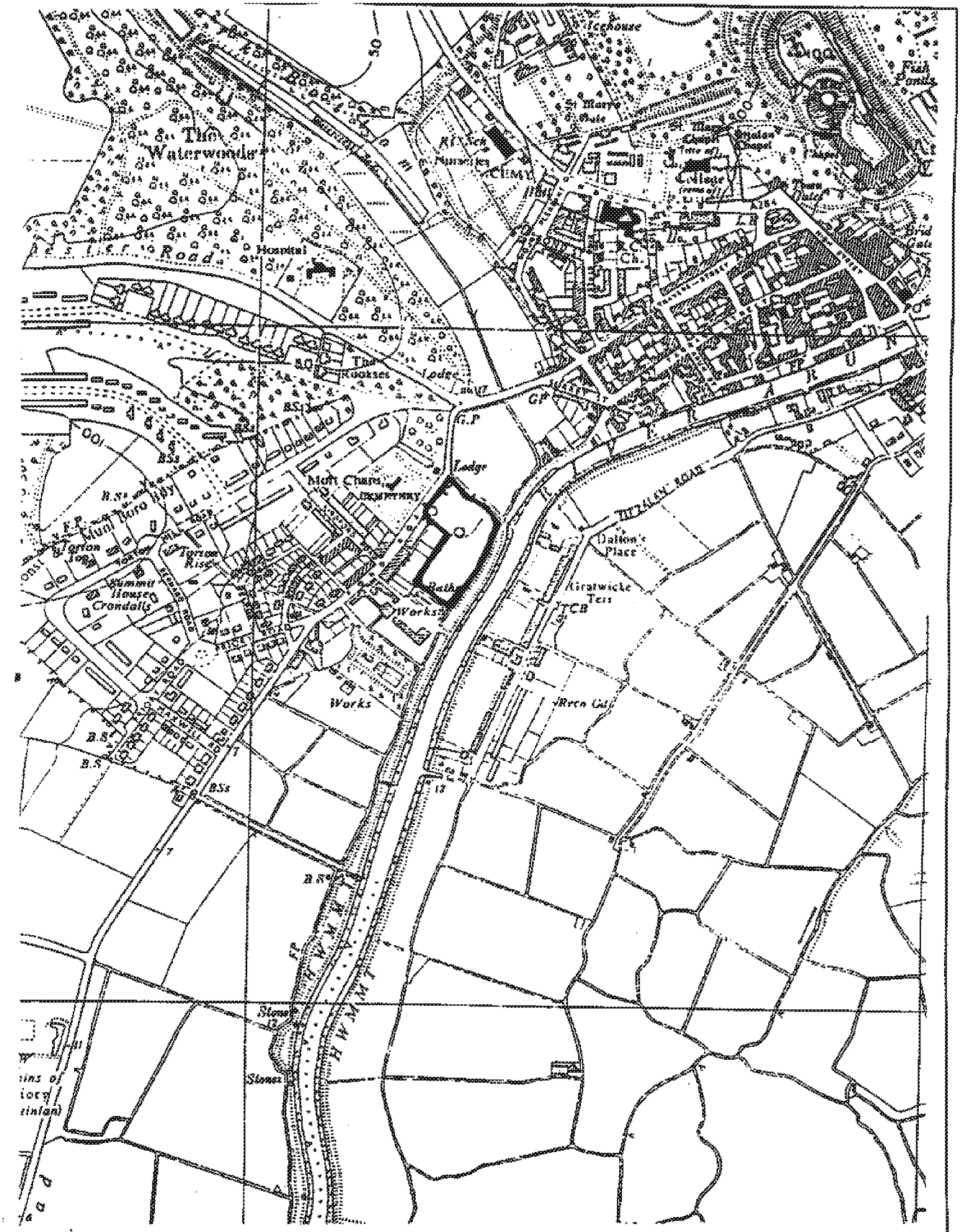
Arundel, Ford Road (Ref SE12)
1938 Ordnance Survey Map

WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road. Tel. (0372) 726140
Epsom, Surrey. KT18 5BW Fax. (0372) 740055

Date	Drawn	Checked	Approved	Scale	Drawing Number	Reference
23/3/94	KM	NJL	JES	NTS	B.7	E5347

ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp



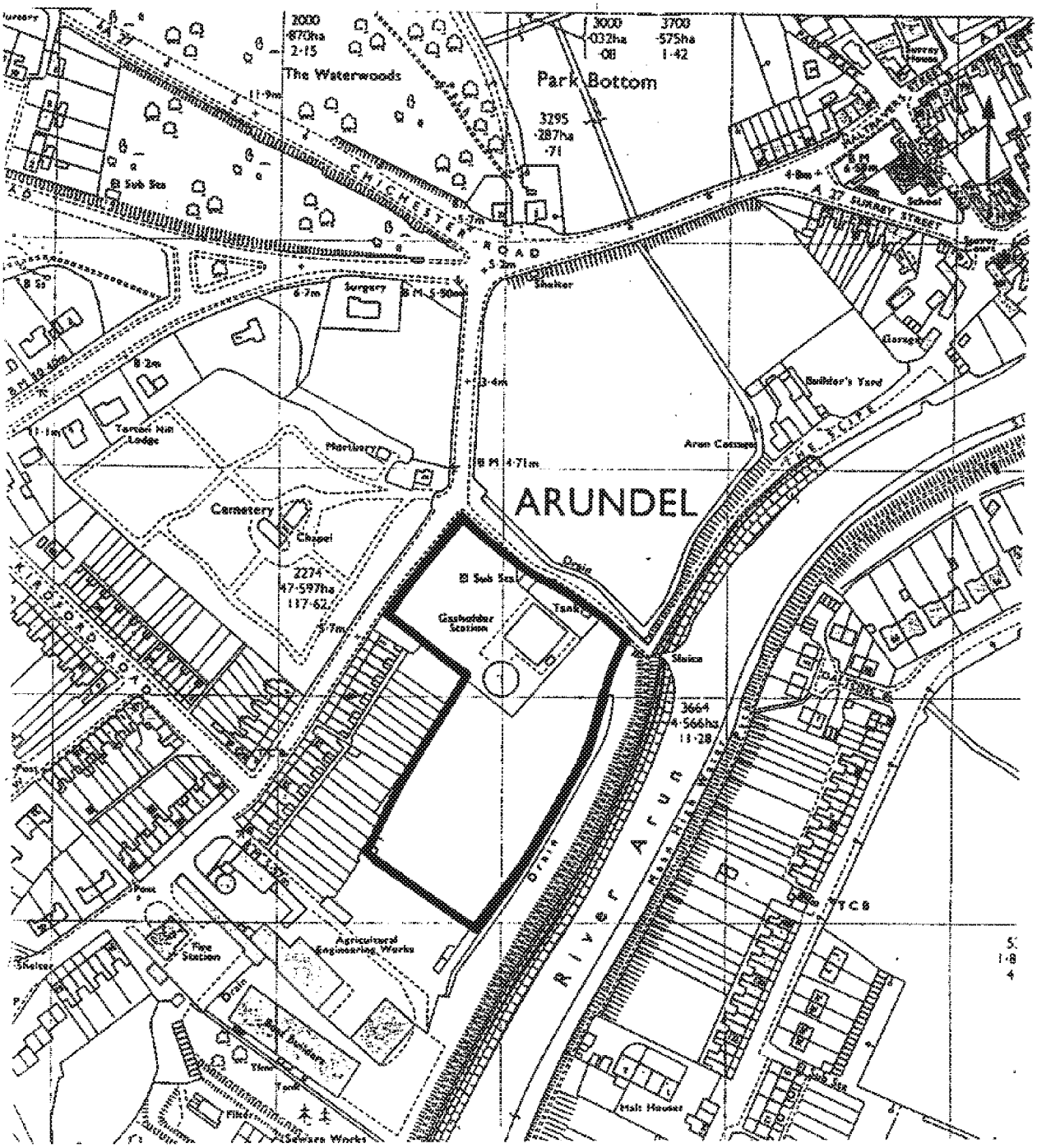
Arundel, Ford Road (Ref SE12):
1961 Ordnance Survey Map

WS Atkins Environment
a division of WS Atkins Consultants Ltd.

Woodcote Grove, Ashley Road. Tel. (0372) 726140
Epsom, Surrey. KT18 5BW Fax. (0372) 740055

e	Drawn	Checked	Approved	Scale	Drawing Number	Reference
3/94	KM	NJL	JES	NTS	B.9	E5347

ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp



Title: Arundel, Ford Road (Ref SE12): 1971 Ordnance Survey Map					**WS Atkins Environment** a division of WS Atkins Consultants Ltd. Woodcote Grove, Ashley Road. Tel. (0372) 726140 Epsom, Surrey. KT18 5BW Fax. (0372) 740055	
Date 3/3/94	Drawn KM	Checked NJL	Approved JES	Scale 1:2500	Drawing Number B.9	Reference E5347

ARUN DISTRICT COUNCIL AB/88/19/PL
E5347/LR860.NL/gp

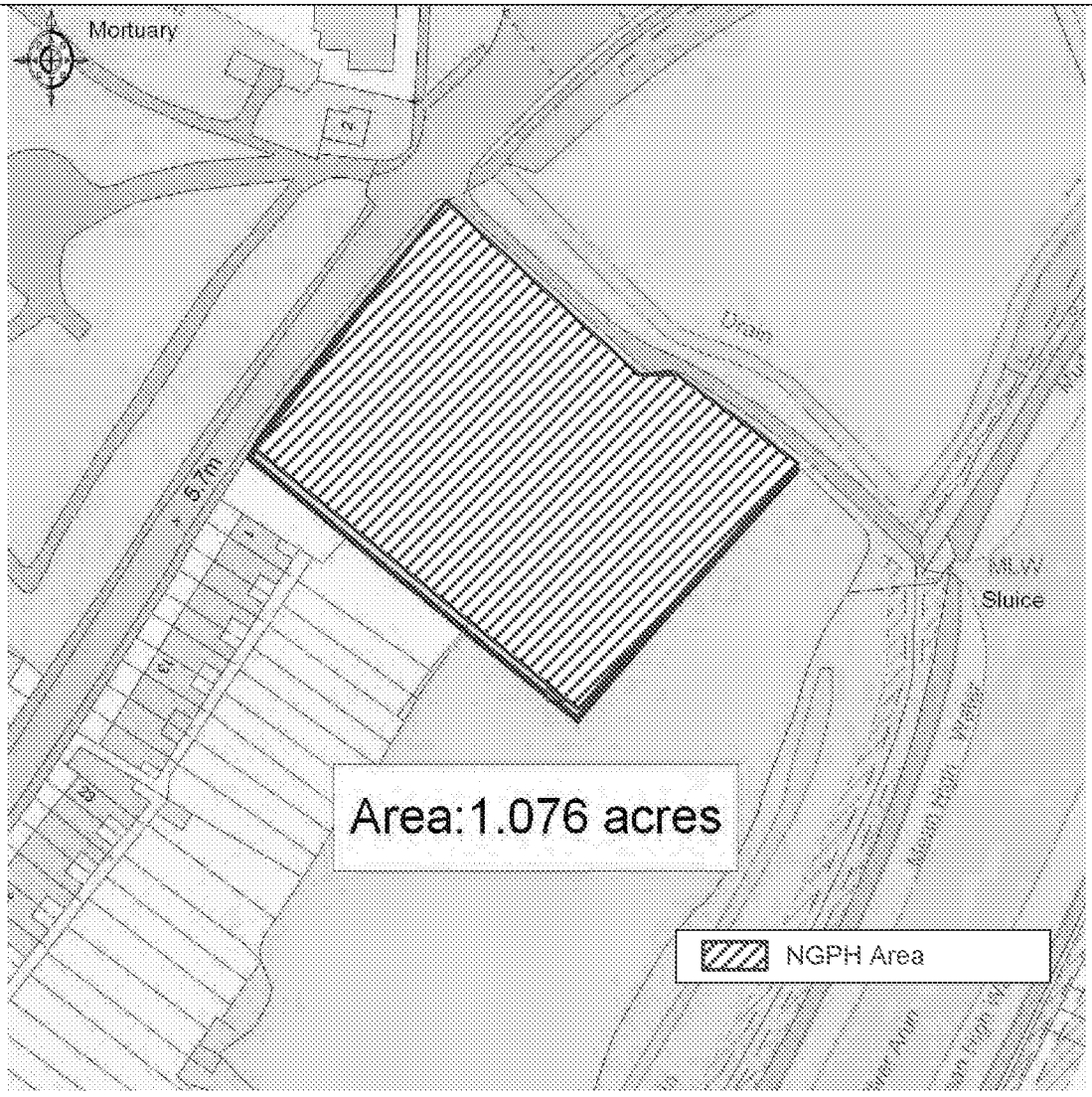
APPENDIX C

Site Visit Anecdotal Information Record

This Appendix could not be completed as British Gas could not identify any current or former employees with a knowledge of the operational history of the site.

APPENDIX D

Ground Investigation Specification



Site Address	**Ford Road, Arundel, West Sussex, BN18 9DX**	NGP Document Tracking code	
Report Title	**Ford Road, Arundel – Environmental Assessment Site Investigation Report**		
Report Type	**Site Investigation**	Retention Period	**Indefinitely**
Site Code	**2551**	Author (Company)	**Atkins**
Report Date	**December 2000**	Factual/Interpretative	**Factual**
Draft/Final	**Final**	H&S File?	**No**
Work Stage*	**Site Investigation**		
Brief description of contents	**Factual Site Investigation**		
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Lattice Property

FORD ROAD, ARUNDEL
MENTOR NO. 015162

ENVIRONMENTAL ASSESSMENT SITE INVESTIGATION

FINAL
FACTUAL
REPORT

DECEMBER 2000

ARUN DISTRICT COUNCIL AB/88/19/PL

WS/Atkins

Client:	**Lattice Property Holdings**
Project:	**FORD ROAD, ARUNDEL** **Mentor No. 015162**
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0. EXECUTIVE SUMMARY

Current Site Status	The site covers an area of approximately 1.1 hectares, (11,045m^2) of which 60% is a grass field let for grazing. The ownership of this area is currently under review. The 40% of the site investigated (total of 0.40 hectares, 3996m^2) was, until recently, occupied by Transco who used the site to control the local gas pressure and for the addition of additives. It is bounded by houses and gardens on the south west and to the north west by Ford Road, beyond which is a cemetery. To the south and east are grazing fields. A drain runs parallel to the north eastern site boundary and into the River Arun via a sluice gate. The Arun flows adjacent to the south (beyond the grazing land) and is separated from the site by a narrow stretch of low lying waterlogged land. The majority of the site is flat with the surrounding land sloping from north west to south east. The houses and road to the west and south west of the site are at a higher level than the site although the gardens slope down to a similar level.
Site History	The first map published of this area in 1841 showed a small gasworks consisting of a single circular holder, a medium sized works building and a small cottage. Within the next century three more gas holders were built, although the first one was demolished at the end of the 19th century and the buildings were expanded. However, by 1994 only the electricity substation, valve pits, toilet and a concrete base of a tank were remaining with the gas holder in the south having been only recently decommissioned. Adjacent landuse, particularly to the south west, has changed dramatically over the years with an ironworks being present between 1899 and 1937, which was then built on by an agricultural engineering works, neither of which showed direct evidence of contamination, based on the initial site investigation carried out by Harrison and Co (1988) (Appendix A).
Hydrogeology	The site is underlain by alluvial silty sandy clay overlying the Upper Chalk aquifer.

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Hydrology	The River Arun flows in a southerly direction approximately 40m south east from the gasworks site, and adjacent to the grazing land. A drainage ditch flows along the north eastern boundary of the site and into the River Arun via a sluice gate.
Site Investigation	A previous desk study by WS Atkins (1994) and site investigation Harrison and Co. (1988) have documented the geology and site history, with further recommendations for site investigation work. Chemical analysis from the current investigation has identified the highest contaminant concentrations to be in the made ground, within the three holder bases in the northern part of the site and below the demolished gas processing area. In particular the 'hotspot' to the north east of the former buildings (TP5) contained visible tarry residues, where a wide range of contaminants were detected. Perched water also had concentrations of a number of dissolved contaminants, some which were also detected within samples of groundwater from the chalk aquifer and the surface water in the adjacent drainage ditch.

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1. INTRODUCTION

General

1.1 WS Atkins was commissioned by Lattice Property Holdings in June 2000 to undertake an assessment of possible ground contamination at their premises at Ford Road, Arundel resulting from historical use of the site for gas production, storage and transmission.

1.2 This document provides a combined factual desk study and site investigation report.

Report Format

1.3 The following sections of the report contain:

(i) a description of the site status, i.e. site use and surface ground conditions;

(ii) a description of the site geology, hydrology and hydrogeology;

(iii) a description of the site history i.e. process activities, waste disposal and potential contaminants; and

(iv) details of the current site investigation undertaken.

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2. SITE LOCATION AND DESCRIPTION

2.1 The Ordnance Survey National Grid Reference No. is TQ014067 (501293E, 106737N) and the site covers an area of approximately 1.1 hectares (see Figure 1 within the WS Atkins Environmental Liability Assessment Report, Appendix A). Full details of the site are provided in Table 2.1 (Site visit record sheet 1). As directed by Lattice Property Holdings the current site investigation refers to the former gas production and storage area only, occupying 3,996m^2 (0.40ha) in the north east of the site (hereafter referred to as the study site). The centre point of the study site has ordnance co-ordinates 501293E, 106737N.

2.2 The site is located adjacent to the north west bank of the River Arun, Ford Road and Old Forge Mews. The site is currently unoccupied, has no telephone contact, and has a postal address of Former Holder Station, Ford Road, Arundel, BN18 9DX.

Table 2.1 : Site Visit Record Sheet

Site Name: Arundel, Ford Road (Ref. SE12) Date of Visit: 06/06/2000
Visited by: Gary Attenborough

SUBJECT	INFORMATION
Current site size and uses	The study site occupies an area of approximately 0.40 hectares. The land use of the adjacent site area identified by Environmental Liability Assessment Report still remains grazing (by horses). This was not investigated by the current investigation due to the land ownership being under review.
Description of ground cover, % of hard standing, (gravel/concentration/tarmac), condition of ground, % infiltration of precipitation	Approximately 25% of the study site ground cover is tarmac and the remainder has a gravel or wood chip surface with sporadic patches of vegetation. [redacted]
Location and type of surface drainage,(culverts, streams, rivers, ponds), approximate water level relative to ground surface	Drainage ditches along NE and SE boundaries. Any direct drainage connections from the site to these ditches was not visible.

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SUBJECT	INFORMATION
Adjacent land uses	*West*: houses with gardens. *North west*: cemetery beyond Ford Road. *North east*: field (appeared not to be grazed). *East and south east*: River Arun separated from site by narrow stretch of waterlogged land, ditch and bund. *South west*: modern residential houses.
Name of adjacent roads/rivers/canals	Ford Road, Old Forge Mews, River Arun.
Level of ground in relation to adjacent areas and other parts of site	The study site itself is generally flat. It is set into the side of a gently sloping hill and the surrounding land gently slopes down from north west to south east. The houses to the west are at a higher level than the site although the southern parts of their gardens are at a similar level.
Site boundary length, type and condition	The study site boundary is 266 metres and consists of a chain link fence in reasonable condition. In the south of the site the fence is partially covered with climbing vegetation.
Access to site boundaries	Access to the study site boundary around the north arm of the site is slightly restricted by chain link security fencing which is positioned approximately 1m in from a wooden boundary fence.
Site services	A high voltage electricity cable supplies the sub-station on the north eastern site boundary. A surface water drain was located running east west across the centre of the site. No other live services were located. Numerous redundant process pipes were identified within fill material in the made ground.
Visibly contaminated areas	Ash and some spent oxide were present on the surface of the gas processing area in the centre of the study site.
Visible evidence of foundations	Broken out old governor tank in north east corner. Concrete slab (tank base) in south east corner.
Present day potentially contaminative activities	None.

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3. GEOLOGY, HYDROGEOLOGY, HYRODOLOGY

3.1 The geology, hydrogeology and hydrology are summarised below. More detail, including interpretation, is provided within the WS Atkins Environmental Liability Assessment Report, 1994. Selected factual exerts from this report are provided in Appendix A.

Geology

3.2 The general geology in the vicinity of the site is shown on the British Geological Survey (BGS) 1:625,000 scale geological map No. 2. Other information was obtained from BGS Well Records No's 21 and 88.

3.3 The solid geology of the study site is Cretaceous Upper Chalk overlain by 2 to 5m of sandy silty clay alluvium associated with the River Arun.

Hydrogeology

3.4 At the time of the Environmental Liability Assessment Report (1994) the study site was not covered by EA groundwater vulnerability or source protection zone maps. Based on current data the site is classified as high vulnerability (soil class H1 - Major Aquifer) and is not currently within a published source protection zone. The Upper Chalk is the principal aquifer in the region and has been used for potable water abstraction in the region (Appendix A – Table 3.1).

3.5 Despite carrying out two rounds of groundwater monitoring on the site, it was not possible to determine the direction of groundwater flow. This is anticipated to be a result of tidal influence from the River Arun extending onto site via the chalk aquifer and due to local variation in groundwater recharge i.e. sandy areas in the clay. [redacted]

3.6 [redacted]

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Hydrology

3.4 A total of four licensed surface water abstractions were located within 2km of the study site (1994) and these are detailed in the WS Atkins Environmental Liability Assessment Report (Appendix A – Table 3.1).

3.5 A drainage ditch is located approximately five metres off-site from the north eastern site boundary. In addition a former surface water drain was located running east west across the central site area. The River Arun flows in a southerly direction approximately 40 metres to the south east of the site.

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4. SITE HISTORY

4.1 The site history (including the wider site area currently used as grazing land) has been assessed using all available plans, records and anecdotal information (see Appendix A). The information has been summarised in Table 4.1 and Figure 3. [redacted] Each feature described in Table 4.1 is given a reference number, which can be used to identify it on Figure 3. The history of adjacent land uses is presented in a similar manner in Table 4.2.

4.2 The following sections outline the principal forms of ground contamination that may be present on the site based on the previous industrial use and surrounding industries.

4.3 [redacted]

4.4 The various activities that are thought likely to have resulted in ground or water resource contamination on this site are listed below in Table 4.3. The potential contaminants from each process or activity are described along with the hazards they pose. The areas can again be identified using the reference numbers that correspond to those given in Figure 3.

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Table 4.1 : Historical Data Summary Sheet : Site Uses

Ref	Use/Feature	1875 OS	1899 OS	1912 OS	1914 OS	1933 OS	1937 OS	1946 OS	1961 OS	1971 OS	1994 SVI	June 2000 SVI
1	Gasholder	North east of operational area	x	x	x	x	x	x	x	x	x	x
2	Drainage ditch	Through north of site and along western boundary	...	...	...	...	x	x	x	x	x	x
3	Buildings	South-western corner of site	_	_	_	_	_	_	_	_	x	x
4	Small circular structure (tank?)	North corner of operational area	x	x	x	x	x	x	x	x	x	x
5	Buildings	Operational area	_	_	_	_	_	Only two in north corner remained	_	x	x	x
6	Gasholder	*	North west corner of operational area	_	_	_	_	_	_	x	x	x
7	Gasholder		North of operational area	...	...	...	...	...	x	x	x	x
8	Small circular structure (tank?)	*	*	North east of operational area	?	?	_	?	?	x	x	x
9	Gasholder	*	*	*	*	*	Centre of site				x	x
10	Electricity sub station	*	*	*	*	*	*	*	*	North-east boundary	_	_
11	Above ground tank	*	*	*	*	*	*	*	*	North-east boundary	Concrete base remaining	Concrete base remaining
12	Valve pits	*	*	*	*	*	*	*	*	Centre of site		
13	Toilet	*	*	*	*	*	*	*	*	North-east boundary		x

KEY	
?	Plan does not show this area or does not provide information
	Feature still present
x	Feature demolished/no longer present
OS	Ordnance Survey Map
BGP	British Gas Plan
AI	Anecdotal information from ex-employee
SVI	Site visit information
*	Feature not present

Notes:

1. [redacted]
2. Feature references correlate to Figure 3: Historical Site Composite Plan.

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Table 4.2 : Historical Data Summary Sheet : Adjacent Site Uses

Boundary	1875 OS	1899 OS	1912 OS	1914 OS	1933 OS	1937 OS	1946 OS	1961 OS	1971 OS	1994 SVI	June 2000 SVI
North west	Greenfield	Cemetery beyond road	_	_	_	_	_	_	_	_	_
North east	Drainage ditch with greenfield beyond	_	_	_	_	_	_	_	_	_	_
South east	Drainage ditch with River Arun beyond	_	_	_	_	_	_	_	_	_	_
South west	Baths and "Works"	Baths, iron works and sewage works	_	_	_	_	Ironworks buildings labelled as "works"	_	Agricultural engineering works, boat builders, sewage works and fire station	New housing estate	New housing estate
West	Greenfield	Terraced houses with gardens	_	_	_	_	_	_	_	_	_

KEY	
?	Plan does not show this area or does not provide information
_	Feature still present
x	Feature demolished/no longer present
OS	Ordnance Survey Map
BGP	British Gas Plan
AI	Anecdotal information from ex-employee
SVI	Site visit information
*	Feature not present

Notes:

1. The baths on the perimeter of the south-western boundary were infilled in the 1950s and 1960s. This area is part of that which has recently been developed for housing.
2. A closed landfill is situated within 250m of the north-west boundary of the site.

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5. PREVIOUS SITE INVESTIGATION

Introduction

5.1 A desk study was carried out for the site (including the area to the south of the study site) by Harrison and Company of Thornton Heath in July 1993 (Report Ref. C604A). The Harrison and Company desk study is provided in full in Appendix A of this report. The report refers to a limited site investigation carried out by them in 1988. The investigation comprised the excavation of 22 trial pits to assess the contamination on the site, including the grazing field to the south. The site investigation report, logs and chemical analysis (Report Ref. C604) are not available but a brief summary of the results is provided in their desk study report and outlined below.

Ground Conditions

5.2 In the north half of the site up to 3.0m (average 1.3m) of made ground was encountered. The nature of fill materials within this area of the site is not given in the summary. Buried structures including concrete, pipes and metal were found in this area.

Chemical Analysis

5.3 [redacted]

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6. CURRENT SITE INVESTIGATION

Introduction



Site Investigation Methodology

6.2 The investigation work was undertaken during the period of 5th to 9th June 2000, comprising the installation of five groundwater monitoring boreholes, two trial trenches, and 14 trial pits. The boreholes were installed by Environmental Sampling Ltd using rotary solid stem augers whilst working under the supervision of WS Atkins. 50mm UPVC monitoring standpipes were installed in each borehole, the construction details of which are provided in Appendix B. The trial pits and boreholes were sampled, photographed (see Appendix B) and logged by WS Atkins personnel in accordance with British Standard 5930 (1999). The ground investigation was carried out in accordance with BG Property Holdings guidance document "Guidance for Assessing and Managing Potential Contamination on Former Gasworks and Associated Sites. Version 2.4, May 1999" (Ref 1).

Exploratory Hole Locations

6.3 Exploratory holes were targeted to investigate features such as the former main gas manufacturing areas and gas holder bases, as well as to obtain information relating to

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boundary conditions and the nature and extent of made ground across the site. [redacted] The groundwater quality within the Chalk aquifer below the site was also investigated. The rationale for the chosen locations of the exploratory holes is detailed in Table 6.1.

6.4 The location and levels of the boreholes and trial pits were surveyed as part of the topographical survey given in Figures 2a and 2b.

6.5 Live and redundant services were identified by a third party tracing contractor prior to the commencement of the works. On the eastern margin of the site an electrical cable entered the sub station, however the majority of the line was off site. A surface water sewer was located west to east across the site (see Figure 3).

6.6 The boreholes were installed by rotary open hole using a solid stem auger.

6.7 Water sampling and monitoring standpipes were installed in each borehole. The construction details are provided in Appendix B. In addition perched water was encountered in TP1, 2, 5, 8 and 12.

6.8 All trial pits and boreholes were logged, sampled and photographed by an experienced Environmental Scientist/Geologist in accordance with British Standard 5930 (1999). All excavation logs and selected photographs (including the general site area) are displayed in Appendix B.

6.9 All groundwater monitoring wells are proposed to be retained to facilitate long term monitoring of the quality and groundwater flow within the Chalk aquifer.

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Table 6.1 : Site Investigation Locations

Location	Rationale for location	Actual Depth	Restrictions
BH 1, BH 2		10m bgl	None encountered
BH3		10m bgl	None encountered
BH4 & BH5		10m bgl	None encountered
TP 1,2,3,4		1.2m to 2.4m bgl	At TP4 the intact holder base was encountered and not breached.
TP 5,6		2.5m & 1.5m bgl	At TP5 redundant cast iron pipes were encountered running parallel to the edge of the site.
TP 7,8,9		1.2m to 1.7m bgl	None encountered
TP 10, 11		1.1m to 2.3m bgl	The holder base was encountered, however trial pits were extended to sample adjacent and below this.
TP 12,13,14		1.15m to 1.6m bgl	At TP14 a concrete slab was encountered at 1.2m bgl which could not be breached and the edge could not be located due to access restrictions.
TT1, TT2		1.6m to 2m bgl	Numerous concrete foundations and cast iron pipes were encountered, the edges which were investigated to identify tanks. However the foundations were not breached.

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