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Aldbrough Gas Storage Facility

Ground Investigation

Interpretative Report

November 2003

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Interpretative Report

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Introduction

1.1 General

The Aldbrough scheme comprises the creation of underground cavities for the storage of natural gas. The cavities are to be situated 1.8km below ground level within a 200m thick deposit of salt.

The site is situated approximately 18km north east of Kingston-upon-Hull, 2.5km south of Aldbrough and 1.5km inland from the North Sea coastline.

1.2 Scope of Investigation

The scope of works carried out for this report included:

- A review of existing ground information
- A ground investigation comprising of 16 No. cable percussive boreholes, 29 No. trial pits and 3 trial trenches.
- Laboratory testing of samples carried out by Norwest Holst Soil Engineering Limited

1.3 Scope of Report

The interpretative report includes the following:

- Review of desk study information
- A description of ground investigation works carried out between 16th and 28th July and description of the laboratory testing
- An assessment of the ground and groundwater conditions
- Presentation of the tests results from the ground investigation
- A geotechnical assessment including advice on suitable foundation types and depth, pavement design, excavations and earthworks

1.4 Principal Sources of Desk Study Information

- Foundation and Exploration Services Ltd Ground Investigation Factual Report, 1992
- British Geological Survey Geological Map, 1:50,000 Hornsea (Sheet 73)
- GeoReport, British Geological Survey
- Environmental Agency Groundwater Vulnerability Map – Sheet 13
- Envirocheck Report produced by Landmark

2 The Site

The site is located approximately 18km north east of Kingston-Upon-Hull, 2.5km south east of the village of Aldborough village in East Yorkshire and 1.5km inland of the North Sea Coastline at an approximate National Grid Reference TA 260 369. A site location plan is presented in Appendix A as Figure A.1.

This section presents a brief review of the site, based upon the EnviroCheck report (see Appendix B), independent researches and site visits.

2.1 Site Description

The site investigated is roughly rectangular in shape and occupies an area of approximately 20 hectares. The construction area of the site is comprised of gently undulating arable farmland. The site is bound to the west by Cess Dale Drain, to the south by East Newton Drain and by hedges and farm ditches to the north and east.

2.2 Site History

Historical maps obtained as part of the EnviroCheck Report (presented in Appendix B) indicate that the site has been arable farmland since the earliest available historical maps dated 1855.

2.3 Geology and Hydrogeology

2.3.1 Drift Geology

The GeoReport obtained from the British Geological Survey (presented as Appendix C) and published 1:50,000 scale map of Hornsea (Sheet 73)[1] indicate that the site is underlain by a deposit of Glacial Till with an overlying body of Alluvium to the south and west. The British Geological Survey has not published a memoir to accompany Sheet 73.

The GeoReport indicates that the alluvium resting on the Glacial Till may be encountered as soft to firm consolidated, compressible silty clay, possibly including layers of silt, sand peat and basal gravel and is estimated to have a thickness of greater than 1m. A stronger desiccated surface zone may be present, however no specific information is available concerning the exact thickness or composition of these deposits.

The Glacial Till is likely to exhibit a highly variable lithology usually sandy with pebbles, cobbles and boulders. Gravel-rich and laminated sand layers are known to exist within the deposits and may be prone to 'running sand'.

2.3.2 Solid Geology

The 1:50,000 geological map indicates that the proposed site is underlain by the Rowe Chalk Formation of the Cretaceous age. The Rowe formation is characterised by white, flint bearing chalk with sporadic marl bands.

It is estimated that the Rowe Chalk Formation is approximately 50m in thickness at the location of the proposed site, dipping at approximately 2° to the north east. The Rowe Formation is shown to be underlain by the Flamborough Chalk Formation.

2.3.3 Groundwater Vulnerability

The Environment Agency Groundwater Vulnerability map (Sheet 13 – Scale 1:100,000) [2] for the Humber Estuary indicates that the proposed site is underlain in the north and east by a non-aquifer (negligible permeability). Such formations are regarded as containing insignificant quantities of groundwater although groundwater flow through such rocks does take place.

The areas to the south and west of the site are underlain by a minor aquifer. These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Although these aquifers will seldom produce large rivers, quantities of water for abstraction, they are important for local supplies and for providing base flows to rivers.

2.4 Potential Sources of Contamination

The information obtained from the EnviroCheck Report suggests that there is little potential for contamination. The site appears only to have been used as agricultural land, with no other land use recorded on the historical maps.

The EnviroCheck report indicates that there are no registered landfills within 1km of the site. It also indicates that no pollution incidents have occurred within 1km of the site.

BRE Guidance [3] indicates that the site is located within an area where no radon protection measures are required.

2.5 Previous Site Investigations

Foundation Exploration Services Ltd undertook a ground investigation of the site in 1992. The investigation was carried out in order to determine ground conditions and to provide information that would assist the 'engineer' in the design of foundations and earthworks

Ten trial pits were excavated in the vicinity of the site, five of which were located within the site boundary. The locations of these trial pits are presented as Figure A.2, the logs and report are presented in Appendix D. The trial pits were excavated to depths of between 1.0m and 2.5m below ground level (bgl) and the lithology was described as Glacial Till in all trial pits. The till generally comprised stiff to very stiff sandy gravelly clay.

A number of geotechnical tests were carried out on samples taken from the exploratory holes, though only moisture content and plasticity index tests were carried out on samples taken from within the site boundary, as discussed below.

Moisture Content tests were carried out on sixteen samples taken from trial pits within the site boundary. Moisture contents ranged from 13% to 45 % with an average of 26%. Plasticity Index tests were carried out on two samples which recorded liquid limits of 42% to 68%, with plastic limits of 23% to 28 %, and plasticity index of 19% to 40%. These results indicate that the material tested comprises intermediate to high plasticity clays.

3 Summary of Ground Investigation Works

3.1 General

Norwest Holst were appointed by Scottish and Southern Energy plc under the Mott MacDonald Framework Agreement 2003 to carry out a ground investigation at the proposed site. The fieldwork was carried out between 16th and 28th July 2003, and comprised the formation of sixteen cable percussive boreholes and twenty mechanically excavated trial pits with associated sampling and in-situ testing

Exploratory hole logs presenting details of the strata encountered, together with sampling records and testing results are summarised in the Norwest Holst Soil Engineering Factual Report[4], ref. F12963, dated 29/09/03. The positioning of all exploratory holes is given on MM Drawing 208202/MM/G001 presented as Figure A.2.

3.2 Cable Percussive Boreholes

Light cable percussion boring of nominal 150mm diameter was undertaken within sixteen boreholes to depths of 5.0 and 10.5m below ground level (BGL).

3.3 Trial Pits

A total of 29 No. trial pits were excavated to depths ranging between 2.3 and 4.0m BGL.

3.4 Trial Trenches

During the ground investigations, three trial trenches were carried out to depths ranging between 3.1 and 4.0m BGL. The trenches were located within the south west area of the site to assist in determining the extent of sand and gravel alluvial deposits present on site.

3.5 In-situ Testing

3.5.1 Standard Penetration Tests

A total of 44 Standard Penetration Tests (SPTs) were carried out in the boreholes to assist in assessing the geotechnical characteristics of the material encountered. Typically SPTs were carried out every 1m and at changes in lithology. The results are presented in Norwest Holst factual report.

3.5.2 Hand Vane Tests

Hand Vane Shear Tests were carried out in all trial pits where clay was encountered, to assess the strength of the clay.

3.6 Sampling

Representative disturbed and undisturbed samples were generally taken at 0.5m intervals and at changes in strata. Details of sampling carried out are indicated on exploratory hole logs in Appendix B of Norwest Holst Soil Engineering Factual Report, ref. F12963.

3.7 Installations / Instrumentation

Standpipes were installed in three of the cable percussive holes (BH's 103, 107 and 117), using 50mm internal diameter uPVC tube. The standpipes were surrounded with pea gravel within their response zones.

3.8 Geotechnical Laboratory Testing

Representative samples taken during the ground investigation works were tested by Norwest Holst Soil Engineering Limited for the following properties in accordance with methods outlined in BS1377 (1990).

1. General Classification

- Moisture content tests (Part 2, Method 3)
- Index Properties (Part 2 , Methods 4 and 5)
- Particle size distribution tests (Part 2, Method 9)

2. Chemical

- Sulphate content of aqueous soil extracts (Part 3, Method 5)
- pH value (Part 3, Method 9)

3. Compaction

- California load bearing ratio (CBR) (Part 4, Method 7)
- Dry density/moisture content relationship tests (Part 4 , Method 3)

- Moisture condition value (MCV) relationship tests (Part 4, Method 5)

4. Shear Strength (total stress)

- Single stage and multi-stage compressive strength in undrained triaxial compression (Part 7, Methods 8 and 9)

5. Compressibility

- Oedometer consolidation tests

4 Groundwater Model

The groundwater levels across the site are important to the design of the proposed development and works associated with its construction. A factual summary of the groundwater observations made follows as Sections 4.1 and 4.2 and an overall assessment of the groundwater conditions is presented as Section 4.3.

4.1 Groundwater Observations During Fieldwork

Groundwater was encountered in nineteen of the exploratory holes, with initial water strikes varying from 8.6m bgl in BH106 to 2.0m bgl in TP202 and TP 220. A summary table of field observations is presented in Table 4.1.

Table 4-1: Groundwater summary table

Exploratory Hole	Groundwater Strike (m)	Level after 20 Minutes (m)
Glacial Till		
BH102	7.2	4.22
BH103	6.7	3.7
BH106	8.6	4.05
BH107	4.6	N/R
BH111	4.0	3.7
BH112	2.1	N/R
BH113	2.3	1.8
TP214	2.7	N/R
TP233	2.6	N/R
Alluvium		
BH111	2.20	2.0
BH118	2.40	1.38
BH119	3.20	2.30
TP201	2.60	N/R
TP202	2.00	N/R
TP206	2.60	N/R

Exploratory Hole	Groundwater Strike (m)	Level after 20 Minutes (m)
TP215	3.15	N/R
TP216	2.40	N/R
TP219	2.50	N/R
TP220	2.00	N/R
TP232	2.30	N/R
N/R - Not Recorded		

4.2 Groundwater Observations in Monitoring Wells

Three groundwater monitoring wells were installed within BH 103, BH 107 and BH 117. Levels were recorded following the completion of works on 31st July 2003, and indicated that the groundwater was shallower in the north western corner of the site at that time. The results are presented below in Table 4.2.

Table 4-2 Groundwater Levels 31st July 2003

Exploratory Hole	*Groundwater Level* (mbgl)
BH103	3.20
BH107	3.10
BH117	0.83

4.3 Assessment of Groundwater Conditions

The water strikes varied from 8.6m to 2.0m bgl, with rises, where recorded, to 1.38m and 4.22mbgl compared with levels in the monitoring wells of between 0.83m and 3.20m bgl and the water level in East Newton Drain and Cess Dale Drain of approximately 3m bgl.

The trend in groundwater levels, relative to Ordnance datum, generally follows the site contours, with a rise in the water levels below Mill Hill towards the centre of the site. This rise is less than the rise in ground level though; hence the water levels fall relative to ground level. Towards the perimeter of the site, the water levels are approximately the same level as the East Newton and Cess Dale drains, which seem to be acting as a general drain to the near surface soils of the site. The well monitoring data is in

accord with this assessment, except at BH117 where the water table seems locally elevated. Such variability in the groundwater may be due to variable permeability within the deposits, which could give rise to locally perched water tables.

5 Strata Encountered and Geotechnical Properties

5.1 General

The strata encountered are generally in accordance with the available published information. The site is underlain by Quaternary Glacial till with some Alluvium (reworked Glacial Till) at the surface in the west and south west of the site.

Table 5.1 summarises the depths and elevations to the top of the strata and their thickness as determined from the ground investigation

Table 5-1: Summary of Ground Conditions Encountered

Strata	Depth to Top of Strata (m BGL)	Thickness (m)	Encountered in
Glacial Till	0.00	Up to 10.5m proven	All exploratory holes
Alluvium	0.8 – 2.6	0.8 – 2.1	32% of exploratory holes

Cross sections are presented as Figures A.3 to A.8.

5.2 Superficial Deposits

5.2.1 Glacial Till

Glacial Till was typically described as firm to stiff, occasionally soft and very stiff brown orange slightly sandy gravelly clay. The gravel component was generally described as sub-angular to sub-rounded and composed of chalk, mudstone, sandstone, quartz and limestone.

The results of in situ and laboratory tests have been used to derive the geotechnical properties for the cohesive glacial deposits as summarised in Table 5.3 and discussed below

(i) In situ Standard Penetration Tests (SPT)

The minimum SPT N value recorded was 9 from BH102; the maximum N value recorded was 35 from BH101 with an average value being 17. The N values indicate that the material is typically firm to stiff, based on the correlation between N value and Cu developed by Stroud and Butler (1975)[5]. A graph plotting SPT values versus depth is presented as Figure A.9.

The results of the SPT tests have been converted to 'mass shear strength' after Stroud and Butler [4] as follows:

Mass Shear Strength, $c = f_1 N$ (kN/m²), where $f_1 = 4.4$ for PI = 36%

As shown in Figure A.10 within the Glacial Till mass shear strengths of 40 kN/m² to 154 kN/m² with a median value of 70 kN/m² were calculated.

(ii) Hand Vane Tests

Hand Vane Shear tests were carried out in all trial pits where clay was encountered, to assess the strength of the clay. Tests were carried out in all trial pits excavated.

A total of 59 peak value tests were carried out at depths between 0.2m and 1.1m bgl, with results ranging from 45 kN/m² to 130 kN/m², with a mean value of 90 kN/m².

A total of 58 remoulded tests were carried out at depths between 0.2m and 1.1m, with results ranging from 15 kN/m² to 76 kN/m² with a mean value of 43 kN/m².

The results of the tests are presented in the Norwest Holst Factual Report (Appendix E) and A.10 of this report.

(iii) Grading Analysis

Particle size distribution (PSD) tests were carried out on samples from across the site at depths between 0.5 and 8.5m bgl. The samples were well graded; twenty three samples were classified as gravely sandy clay, with one classified as clayey sand (BH106 8.5m) and one as sand and gravel (BH111 1.0m).

The results are presented in Figure A.11.

(iv) Classification tests

Atterberg Limit and natural moisture content tests on samples of Glacial Till recorded plastic limits of 13% to 27%, liquid limits of 29% to 69%, plasticity indices of 12% to 42% and natural moisture contents of 12% to 36%. Half of the samples were classified as intermediate plasticity clays and the

remainder as low to high plasticity. The results of the tests are presented in Figure A.12 (Casagrande Plasticity Chart) and Figure A.13 (variation of index properties with depth).

(v) California Bearing Ratio Test

Eleven California Bearing Ratio (CBR) soaked tests were carried out upon material taken from depths between 1.0m and 3.0m bgl. Samples taken from TP202 1.0m and TP214 1.0 produced accepted CBR results at 2.1% and 0.81% respectively. The remaining nine samples had CBR values ranging from 1.0% to 3.2% for the top of the samples, which is consistent with the samples described above. However, the CBR values for the base of the samples range from 0.76% to 8.55% indicating that there may have been a problem with incomplete soaking of the samples at the laboratory.

Soaked tests represent onerous testing conditions and mirror the ground being subject to prolonged induration by water. Higher values may be more representative, if good earthworking working practice is adhered to.

(vi) Quick Undrained Triaxial Tests

The results of quick Undrained Triaxial tests undertaken on samples of Glacial Till recorded undrained shear strength of 41 kN/m² to 222 kN/m² with a median value of 132 kN/m². This is indicative of a firm to very stiff, generally stiff, consistency. The results are shown graphically in Figure A.10.

(vii) Bulk Density

Bulk Density determinations within the Glacial Till ranged from 1.88 Mg/m³ to 2.21 Mg/m³ with dry densities of 1.64 Mg/m³ to 1.94 Mg/m³.

(viii) One dimensional consolidation tests

One-dimensional consolidation tests on samples of glacial till recorded coefficients of volume compressibility m_v of 0.08 m²/MN to 0.16 m²/MN at pressure increments of 100kN/m2 above effective overburden pressure (p'0 to p'_0 +100 kN/m²). The results are indicative of clay of low to medium compressibility.

Additionally, moduli of volume compressibility have (m_v) have been derived from the 'N' values after Stroud and Butler [5] as follows:

Moduli of volume of compressibility, $m_v = \frac{1}{f_2 N}$ (m^2/MN) for $f_2 = 440$ kN/m^2 For PI = 36%

For Glacial Till this correlation indicates values of 0.06 m^2/MN to 0.25 m^2/MN with a median value of 0.14 m^2/MN are indicative of low to medium compressible clays.

(ix) Moisture Condition Value

Thirty-Six samples were tested for Moisture Condition Value, the results ranged from 4.6 to 13.8 with a median of 8.7. A Moisture Condition calibration plot is presented as Figure A.14.

(x) Compaction Tests

Compaction tests were carried out on four samples of Glacial Till from across the site, a summary of the results are presented in Table 5.2 below:

Table 5-2 Summary of Compaction Test Results

Exploratory Hole Number	Depth (m bgl)	Maximum Dry Density (Mg/m³)	Optimum Moisture Content (%)
TP208	2.0	1.8	16
TP211	1.0	1.79	16
TP212	1.0	1.82	16
TP223	2.0	1.83	15

The average Optimum Moisture content is 15.75%, the average natural moisture content for Glacial Till is 18% this indicates that some of the material on site may be too wet for use in earth works.

The average Maximum Dry Density is 1.81 Mg/m³, for earthworks the clay should be compacted to 95% of this value.

Table 5-3: Summary of Geotechnical Properties for Glacial Till

Geotechnical Property	Glacial Till			
	Maximum	Minimum	Median Value	Number of Tests
SPT N Values	35	9	16	44
Field Undrained Shear Strength Hand Vane Peak Values (kN/m^2)	130	45	90	82
Field Undrained Shear Strength Hand Vane Remoulded Values (kN/m^2)	76	15	43	79
Natural Moisture Content NMC (%)	36	12	17	49
Liquid Limit LL (%)	69	29	39	49
Plastic Limit PL (%)	27	13	17	49
Plasticity Index (%)	42	12	23	49
Coefficient of Volume Compressibility, m_v (m^2/MN) At $p' = 0$ to $0 + 100kN/m^2$	1.16	0.08	0.11	14
Equivalent Coefficient of Volume Compressibility, m_v (m^2/MN)	0.06	0.25	0.14	44
Laboratory Undrained Shear Strength c_u (kN/m^2)	222	41	132	46
Mass Shear Strength c_u (kN/m^2) (After Stroud and Butler)	154	40	70	44
Bulk Density (Mg/m^3)	2.21	1.88	2.14	18
Dry Density (Mg/m^3)	1.94	1.64	1.84	18
Moisture Condition Value	13.8	4.6	8.7	36

5.2.2 Alluvium

Alluvium was encountered in Trial Pits 201,202, 206, 215,216, 218 – 220, 232, 233 and TPE3 all to the west and south of the site. The thickest layer of alluvium of 2.1m was encountered at TP 220 in the south eastern corner, which was also the location of the deepest proven depth. In general the alluvium was described as slightly clayey sand with gravel and occasional cobbles. The gravel and cobbles are described as sub angular to sub rounded and comprised of chalk, sandstone, limestone and mudstone, occasionally slate and dolerite. The overall composition of the alluvium is similar to that of the Glacial Till indicating that it maybe reworked till.

The results of the testing undertaken is described in detail below and summarised in table 5.4.

(i) In situ Standard Penetration Tests (SPT)

The minimum N value recorded was 9, the maximum N value recorded was 22 with an average value being 14. The N values indicate that the material is typically firm, based on the correlation between N value and Cu developed by Stroud and Butler [4].

(ii) Hand Vane Tests

Hand Vane Shear tests were carried out in all trial pits where clay was encountered, to assess the strength of the clay.

A total of 23 peak value tests were carried out at depths between 0.2m and 1.1m bgl, with results ranging from 32 kN/m² to 130 kN/m², with a mean value of 71 kN/m².

A total of 21 remoulded tests were carried out at depths between 0.2m and 1.1m, with results ranging from 6 kN/m² to 74 kN/m² with a mean value of 41 kN/m².

The results of the tests are presented in the Norwest Holst Factual Report (Appendix E) and Figure A.10.

(iii) Grading Analysis

Particle size distribution (PSD) tests were carried out on samples from across the site at depths between 0.5 and 2.6m bgl. The samples were well graded, three samples were classified as gravely sandy clay (BH118 0.6m, BH118 0.8m and BH220 1.0m), with three classified as clayey sand (BH106 8.5m, TP219 1.0 and TP220), two as clayey sandy gravel (TP233 2.00m and BH118 2.50m), one as

sandy clay (BH112 1.0m), one as sandy gravelly clay (BH112 1.8m), one as sandy gravel (BH112 2.6m) and one as gravelly clayey sand (BH219 1.0m).

The results are represented within the lower half of Figure A.11.

(iv) Classification tests

Atterberg Limit and natural Moisture content tests on samples of Alluvium recorded plastic limits of 19% to 26%, liquid limits of 50% to 69%, plasticity indices of 30% to 46% and natural moisture contents of 14% to 34%. All of the samples were classified as intermediate to high plasticity clays. The results of the tests are presented in Figure A.15 (Casagrande Plasticity Chart) and Figure A.12 (variation of index properties with depth)

Table 5-4: Summary of Geotechnical Properties for Alluvium

Geotechnical Property	Alluvium			
	Maximum	Minimum	Median Value	Number of Tests
SPT N Values	22	9	12	8
Field Undrained Shear Strength Hand Vane Peak Values (kN/m^2)	130	32	66	23
Field Undrained Shear Strength Hand Vane Remoulded Values (kN/m^2)	74	6	40	21
Natural Moisture Content NMC (%)	34	14	34	6
Liquid Limit LL (%)	69	50	67	5
Plastic Limit PL (%)	26	19	24	5
Plasticity Index (%)	46	30	37	5

5.3 Solid Geology: Rowe Chalk Formation

The published geological map indicates that Rowe Chalk Formation underlies the superficial deposits. However, the investigation did not encounter any solid geology due to the exploratory holes being limited to a maximum depth of 10.50m bgl.

6 Geotechnical Assessment

6.1 General Ground Constraints

The following general constraints on the development of the site have been identified:

- The geology of the site has been identified as primarily Glacial Till. The depositional nature of this material means that it may be potentially highly variable. Alluvium in the form of reworked Glacial Till was identified within the exploratory holes in the south and south west of the site overlying the till. These layers were more sandy than the Till below

- The variability of the ground will lead to variable permeability within the deposits with a varying water table depth and possible perched water tables. This was confirmed by the groundwater monitoring which indicates the water level was approximately 0.83m bgl to 3.2m bgl.

6.2 Foundations

Pad or strip foundations, subject to settlement tolerances, are considered to be appropriate for the type of construction on the majority of the site i.e. for a development comprising relatively lightly loaded structures. Where foundations are to be founded directly onto the Glacial Till at a minimum founding depth of 1.0m, it has been estimated that the allowable bearing pressure applied by strip / pad footings up to 2m breadth may be up to 125kPa.

Assuming an m_v of 0.1 - 0.16 m^2/MN, as indicated from the oedometer results, we estimate that post-construction settlement of strip or pad foundations within the Glacial Till will be between 10 and 30mm.

For heavier structures, these cases need to be individually addressed in terms of bearing capacity and settlement.

However, the south western area of the site is underlain by the less competent alluvium, which is heterogeneous and has associated with it a soft layer of clay. This clay layer has lower bearing capabilities and will exhibit larger foundation settlements, compared with the rest of the site, with the additional risk of significant differential movements. As a result, it is recommended that shallow foundations are not used in this area, unless the loading is particularly light and tolerant of differential movement.

The analyses are based on the SPT data primarily, which seem to imply consistently lower values of shear strength than the laboratory results.

6.3 Floor Slab

It is anticipated that ground bearing floor slabs would be appropriate for the majority of the site, bearing directly onto the Glacial Till or engineered fill. All slabs should be designed for some differential movement, the magnitude of which will depend on the floor levels and the applied loads. Any soft spots below the slabs should be excavated and replaced with suitably compacted granular fill.

Radon guidance indicates that no radon protection measures are needed at this site.

6.4 Drainage and Excavations

The groundwater model for the site indicates that the water level is typically 3m to 4m bgl, except below Mill Hill, where it falls to nearer 8m bgl. As a result only sump and pump groundwater control is likely to be necessary across the whole site during construction. More comprehensive drainage is unlikely to be needed given the largely cohesive nature of the ground, the generally slow rate of outflow of water from the granular material in the exploratory holes and the low water levels recorded. However, it should be noted that the ground investigation was carried out in the height of summer, and localised inflow may be stronger during the winter and spring months.

Shoring should be allowed for in all excavations in the area of the alluvial material due to the possibility of granular material that could slump and undermine the overlying clay. Outside the alluvial area any excavations will need shoring if man access is needed and shoring if the excavations are going to remain open for more than a day or two.

6.5 Road Pavements

Road pavements are to be constructed on the Glacial Till either in situ or placed as Class 2C compacted material. The plasticity index for this material ranged from 12 – 46% with an average value of 25%. For design using Highways Agency Design Manual 25/94, the PI was conservatively taken to be 40%. For this scenario assuming a low water table and average construction conditions, the equilibrium subgrade CBR should be taken to be 3% for design. The capping and thickness design guidance indicates that either 150mm sub-base on 350mm capping or 300mm sub-base with no capping, would be appropriate for the pavement.

6.6 Earthworks

Modification of the site levels is likely to be required, with recontouring of up to 3m likely to be required. For shallow cuttings within 3m of the original ground surface the material encountered is likely to be cohesive Glacial Till.

Key parameters for the materials encountered are summarised in Table 6.1 based on the test results from the site investigation.

Table 6-1: Summary of Key Geotechnical Properties of Glacial Till

Geotechnical Property	Results
Moisture Content (%)	Range: 12 - 36 Median: 17
Plastic Limit (%)	Range: 13 – 27 Median: 17
Plasticity Index (%)	Range: 12 – 12 Median: 23
Standard Penetration Test N Value	Range: 9- 35 Median: 16
MCV	Range: 4.6 – 13.8 Median: 8.7

For the purposes of guidance the material likely to be encountered maybe classified as a Class 2C 'Stoney Cohesive' material in accordance with the Specification for Highway works.

Assuming a CBR of 3% and an approximate correlation between Cu and CBR, a minimum Cu of 60kPa and a maximum Cu of 125 kPa has been inferred to be required for engineered cohesive fill at the site. Based on a moisture content range of 14 – 17%, which would appear to be acceptable, this equates to a design specification MCV in the range of 10 to 14.

Due to the relatively low height and slope gradients of the proposed landforms, it is considered that slope instability will not be an issue. However, if slopes are to be steepened, either in a temporary or permanent situation, then the stability of the slopes should be re-considered. Additionally, this should be undertaken if ground conditions show a marked reduction in competence in any particular locality, though and in view of the proposed gradients, the need for slope gradient revision is considered to be unlikely.

6.6.1 Summary

The forgoing figures may be used for preliminary design purposes. However, it should be noted that assessment of acceptability of the material is dependent on numerous factors and must take into account the following:

- The lateral and vertical variation in the strata
- The presence of perched groundwater and techniques used to control by dewatering
- The methods of compaction adopted by the contractor and care taken to separate unacceptable materials
- The weather conditions at time of excavation transport storage and deposition.

During construction it will be essential to select acceptable materials with care, and to use proper working methods of handling, compaction and testing to ensure that materials are placed to appropriate standards. Good compaction of materials is essential to ensure stability of the earthworks and to minimise future ground settlement. Finished earthwork slopes should be topsoiled as soon as practical to reduce the vulnerability to slope erosion. Validation of compacted materials should be carried out to ensure the works meet specification criteria.

6.7 Durability of buried concrete

The results of water soluble and pH determinations on samples of Glacial Till are presented in the factual report prepared by Norwest Holst Soil Engineering Limited Appendix E. Water Soluble Sulfate as SO4 concentrations ranged from 0.021g/l and 0.292 g/l and pH ranged from 7.1 to 8.4.

These results have been assessed against Table 2 of BRE Special Digest 1 (Part 1) [6]. For greenfield sites and mobile groundwater the Design Sulfate class is DS-1 and the ACEC classification for the site is AC-1.

7 References

(1) 1:50,000 Geological Map of Hornsea, Sheet 73 (1998) British Geological Survey

(2) 1:100,000 Groundwater Vulnerability Map of Humber Estuary, Sheet 13 (1999) Environment Agency

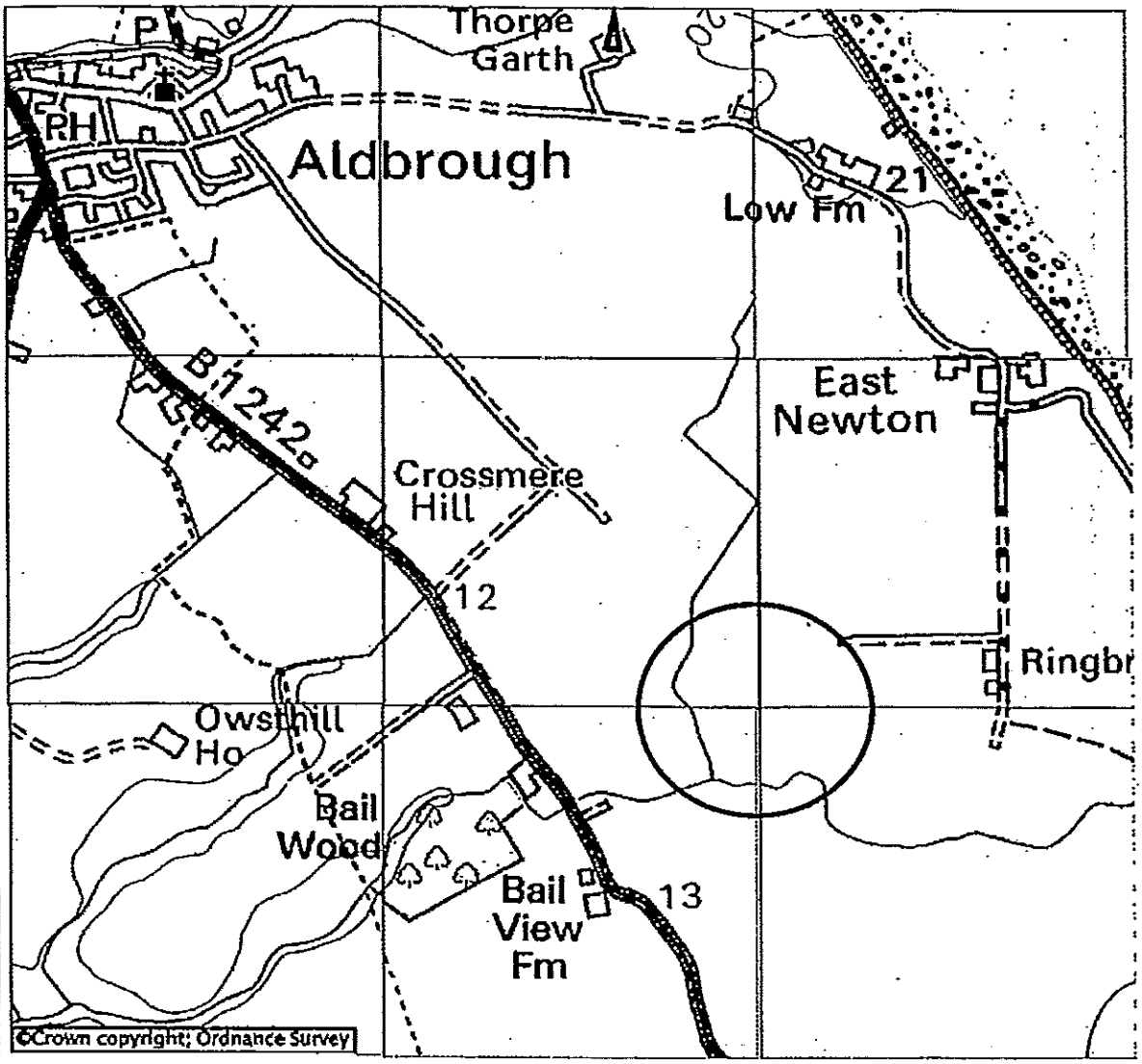
(3) BRE211:1999, Radon:Guidance on Protective Measures for New Dwellings, DETR

(4) Norwest Holst Soil Engineering Factual Report (29 Septermber 2003) Ref F12963

(5) The Standard Penetration Test and the Engineering Properties of Glacial Materials (1975) Stroud and Butler,

(6) Concrete in Aggressive Ground: SD1 (2001)BRE/DTI

APPENDIX A

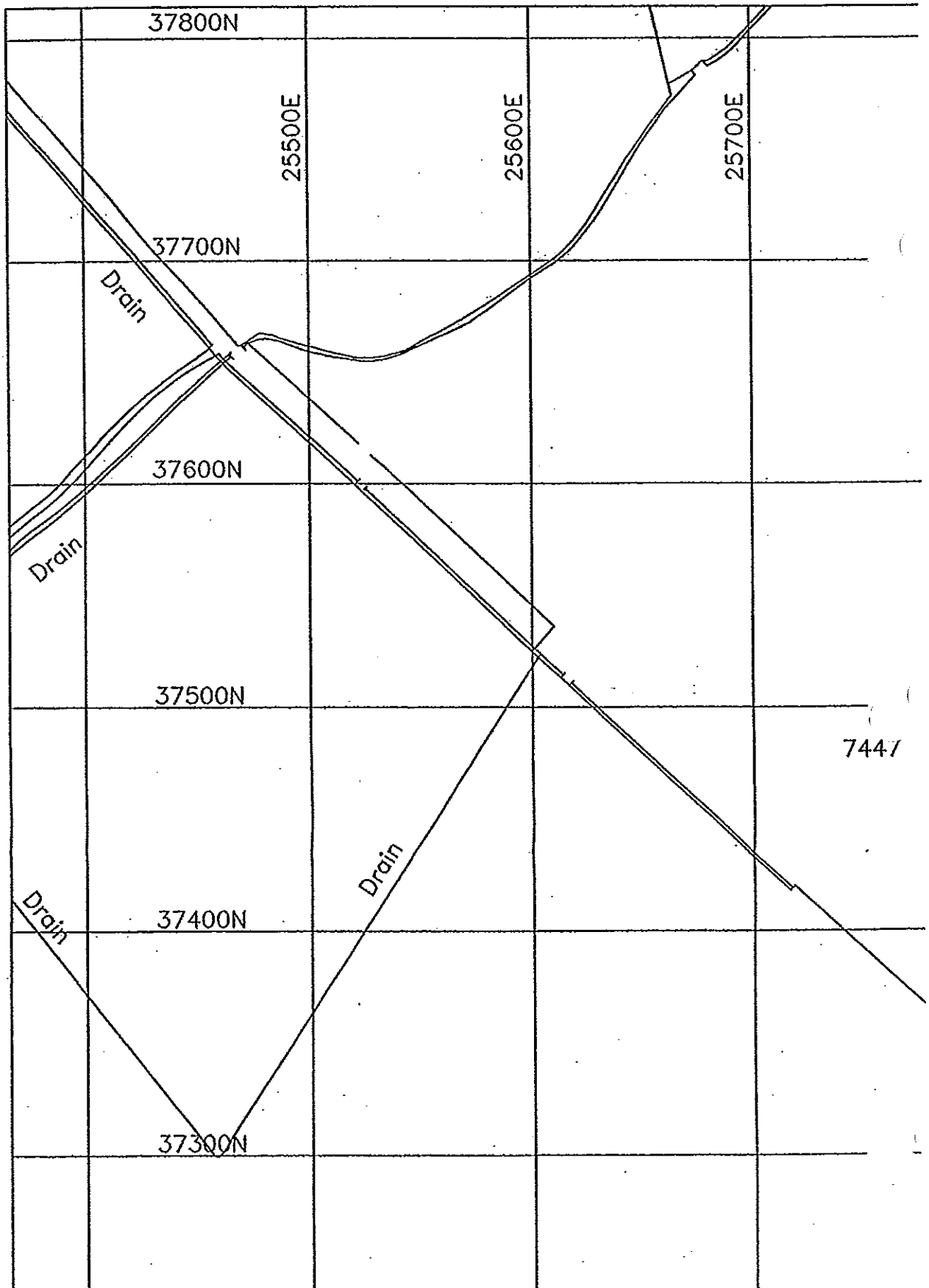


Title
Site Location

Mott MacDonald

1 Atlantic Quay
Broomielaw, Glasgow, G2 8JB
Tel: (0141) 222 4500

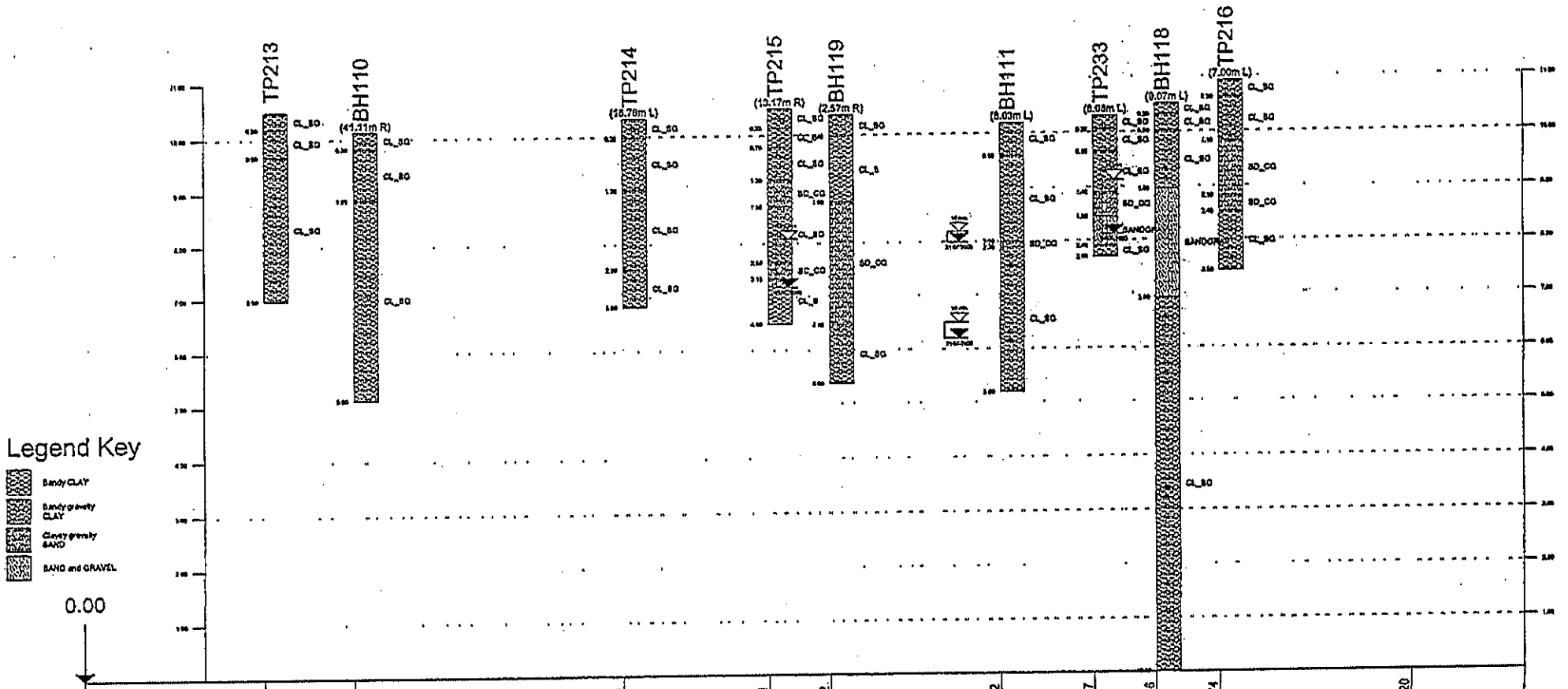
Project	Project No	Fig
Aldbrough Gas Storage Factility	208202	A.1
Client	Report No	Rev
Scottish and Southern Energy plc	208202/GLA	A


37800N
25500E
25600E
25700E
37700N
Drain
37600N
Drain
37500N
7447
Drain
Drain
37400N
37300N

PROJECT REF: F12963
LOCATION: (Section: A - A')
CLIENT: Scottish and Southern Energy PLC

TITLE: Aldbrough Gas Storage Facility

ENGINEER: Mott MacDonald



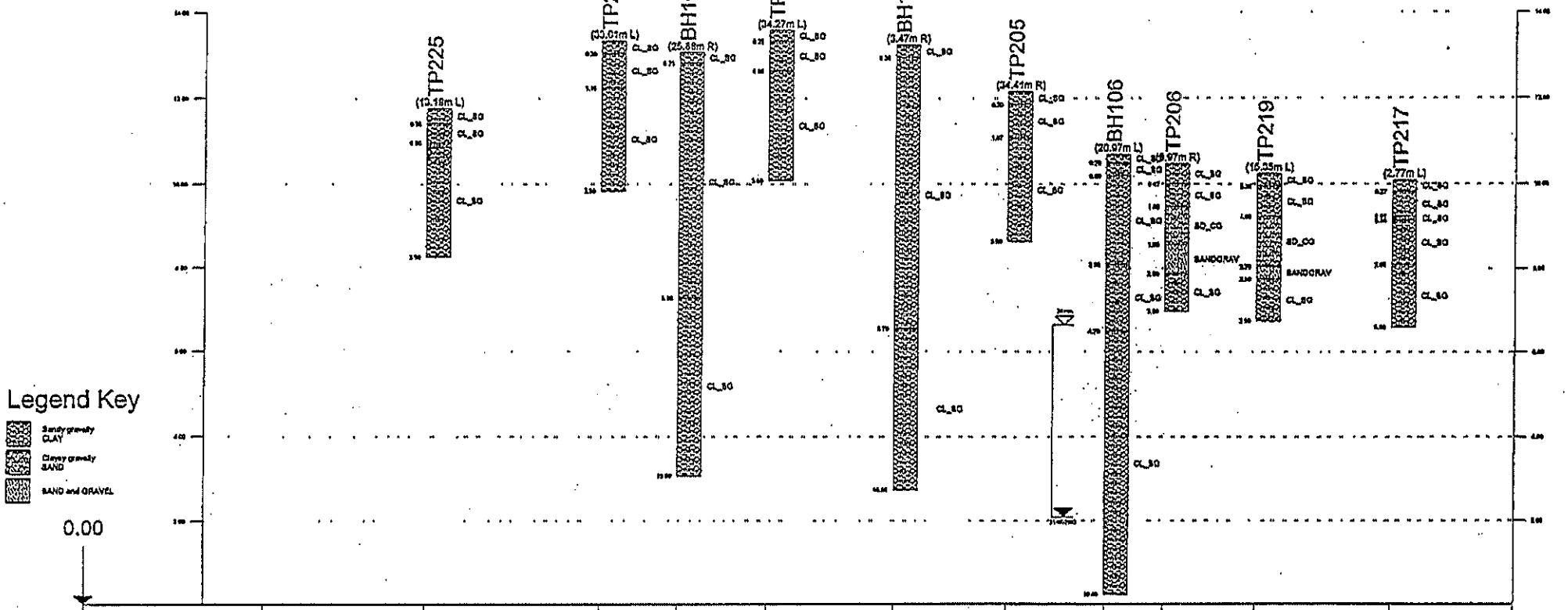
Chainage (m)	0.00	25.44	102.25	144.01	161.62	210.72	237.67	255.46	273.74	328.20			
Elev. (mAOD)	10.49	10.13	10.33	10.49	10.37	10.19	10.30	10.51	10.92				

SCALE: Horizontal 1:1700 Vertical 1:110
(Plotted to Scale for paper size A4)

Created 7 November 2003 at 18:04 from HoleBASE III

PROJECT REF: F12963
LOCATION: (Section: B - B')
CLIENT: Scottish and Southern Energy PLC

TITLE: Aldbrough Gas Storage Facility
ENGINEER: Mott MacDonald



Chainage (m)	0.00	54.29	113.43	139.96	170.38	213.46	251.90	285.51	305.57	336.80	382.32
Elev. (mAOD)		11.77	13.35	13.08	13.59	13.25	12.15	10.69	10.47	10.24	10.09

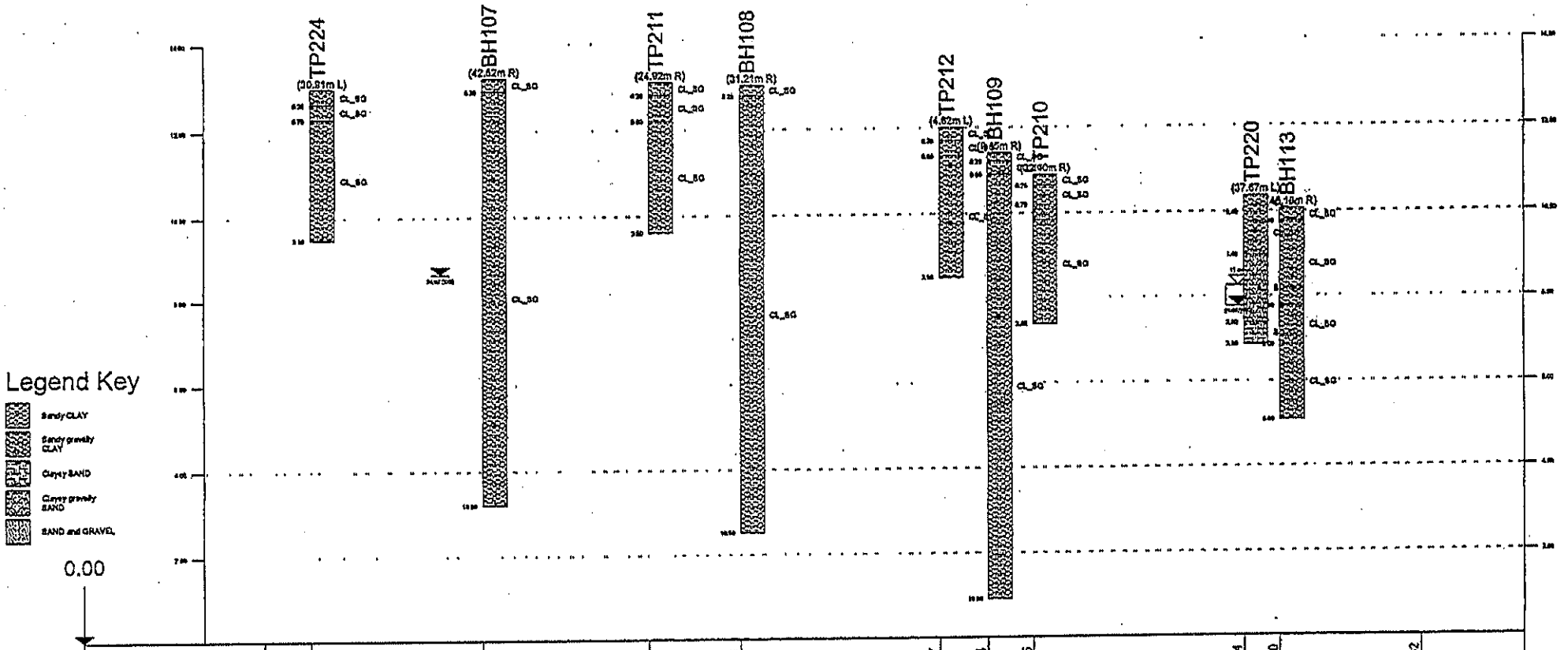
SCALE: Horizontal 1:2000 Vertical 1:140
(Plotted to Scale for paper si[illegible]4)

Created 7 November 2003 a[illegible]

PROJECT REF: F12963
LOCATION: (Section: C - C')
CLIENT: Scottish and Southern Energy PLC

TITLE: Aldbrough Gas Storage Facility

ENGINEER: Mott MacDonald



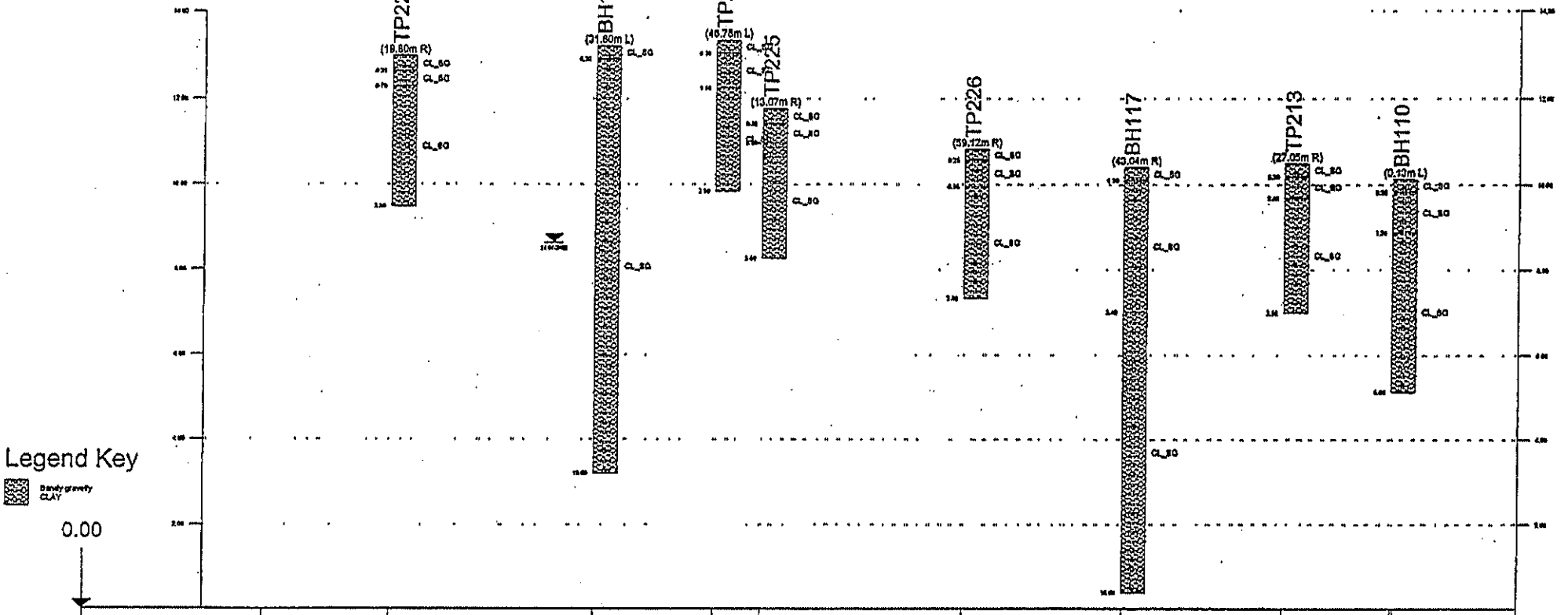
Chainage (m)	0.00	14.68	69.25	122.56	151.86	215.77	231.24	245.95	313.64	325.10	369.62
Elev. (mAOD)		12.99	13.22	13.11	13.03	12.00	11.41	10.89	10.37	10.05	

SCALE: Horizontal 1:1900 Vertical 1:140
(Plotted to Scale for paper size A4)

PROJECT REF: F12963
LOCATION: (Section: D - D')
CLIENT: Scottish and Southern Energy PLC

TITLE: Aldbrough Gas Storage Facility

ENGINEER: Mott MacDonald



Chainage (m)	0.00	46.72	122.49	167.08	184.66	260.06	319.82	379.57	419.58
Elev. (mAOD)	12.99	13.22	13.35	11.77	10.82	10.40	10.49	10.13	

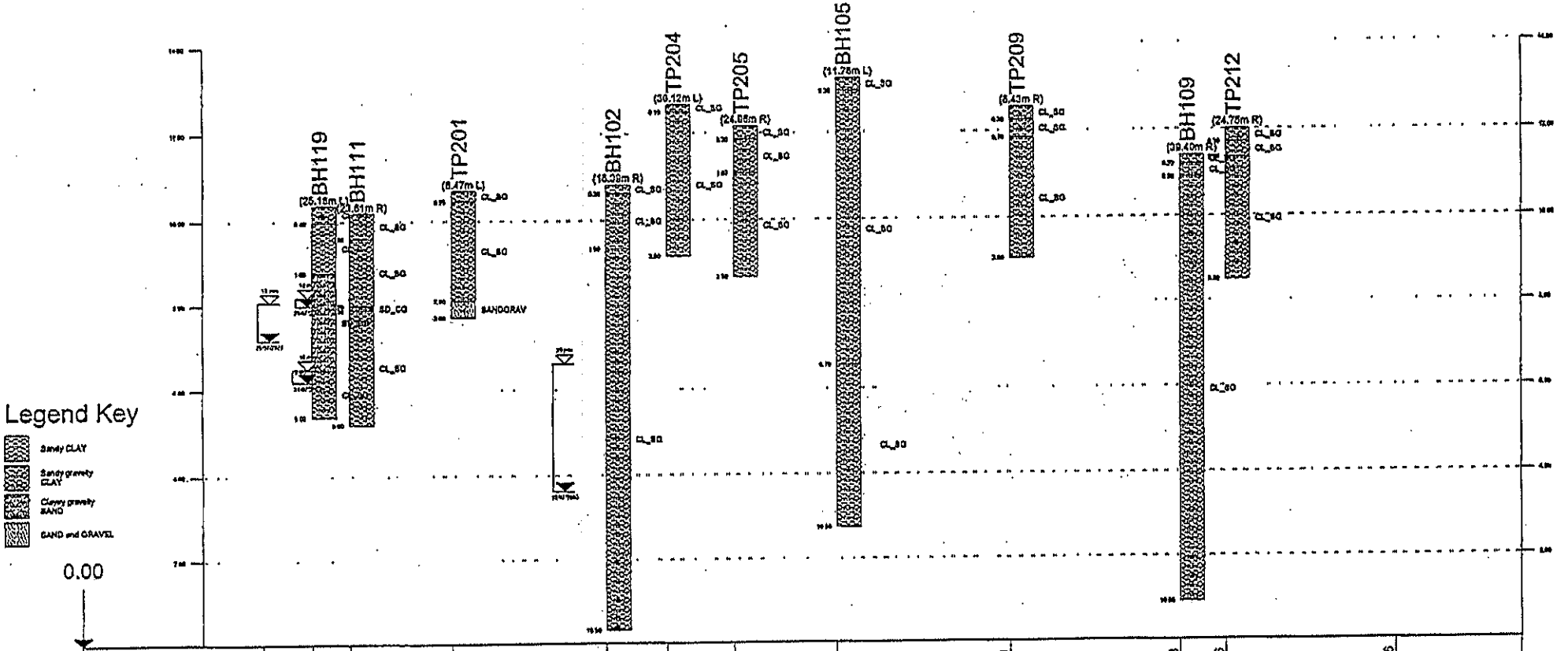
SCALE: Horizontal 1:2200 Vertical 1:140
(Plotted to Scale for paper si[illegible] 4)

Created 7 November 2003 [illegible]

PROJECT REF: F12963
LOCATION: (Section: E - E')
CLIENT: Scottish and Southern Energy PLC

TITLE: Aldbrough Gas Storage Facility

ENGINEER: Mott MacDonald



Chainage (m)	0.00	15.61	27.57	59.50	109.38	128.80	150.41	183.34	239.09	293.83	308.56	362.56
Elev. (mAOD)		10.37	10.19	10.71	10.83	12.65	12.15	13.25	12.51	11.41	12.00	

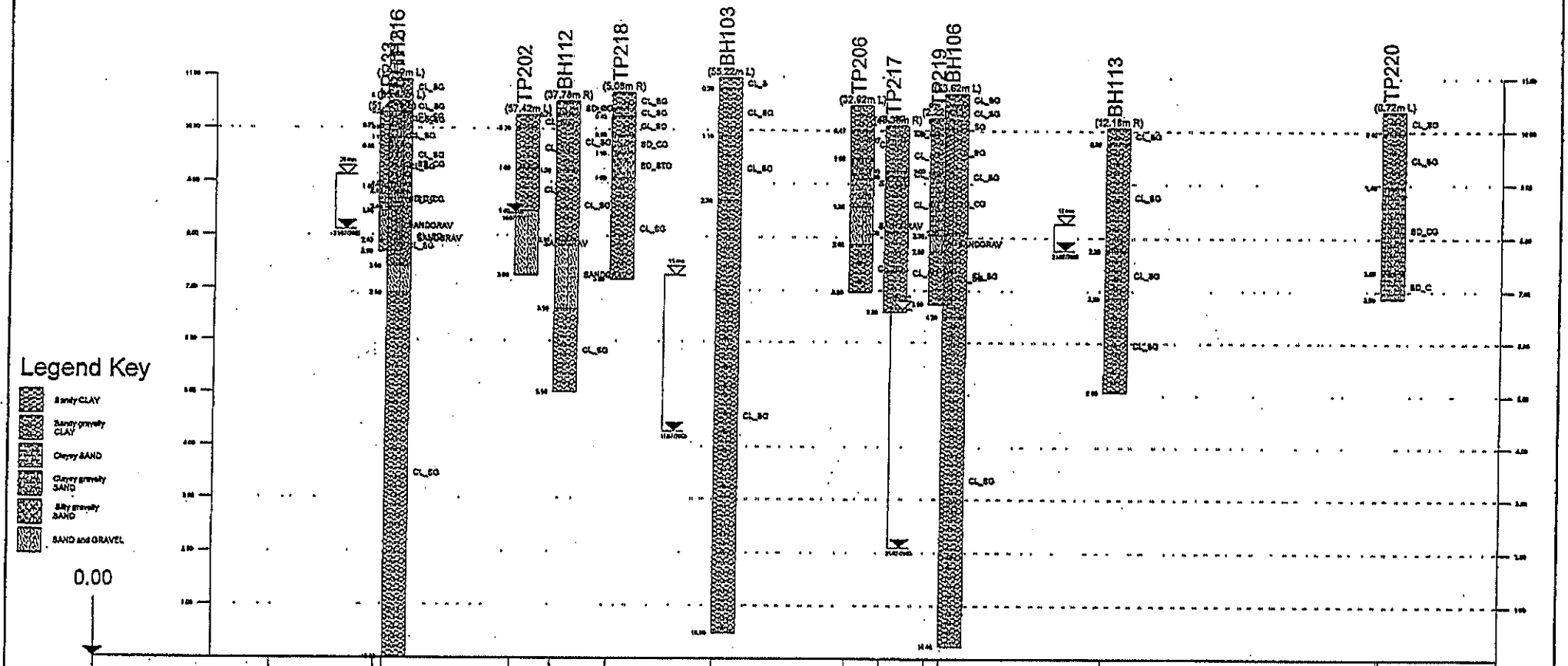
SCALE: Horizontal 1:1900 Vertical 1:140
(Plotted to Scale for paper size A4)

Created 7 November 2003 at 16:18 from HoleBASE III

PROJECT REF: F12963
LOCATION: (Section: F - F')
CLIENT: Scottish and Southern Energy PLC

TITLE: Aldbrough Gas Storage Facility

ENGINEER: Mott MacDonald



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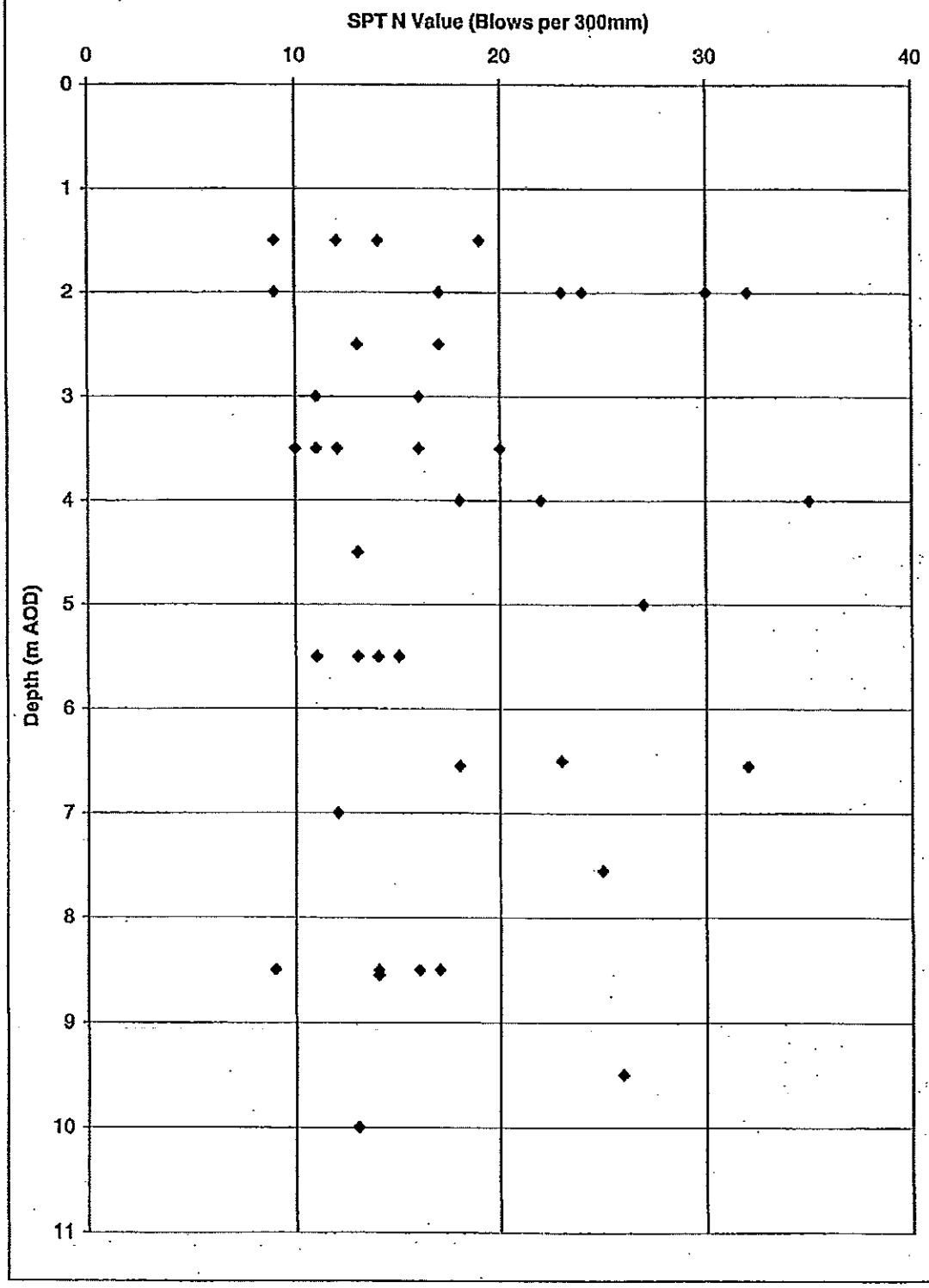
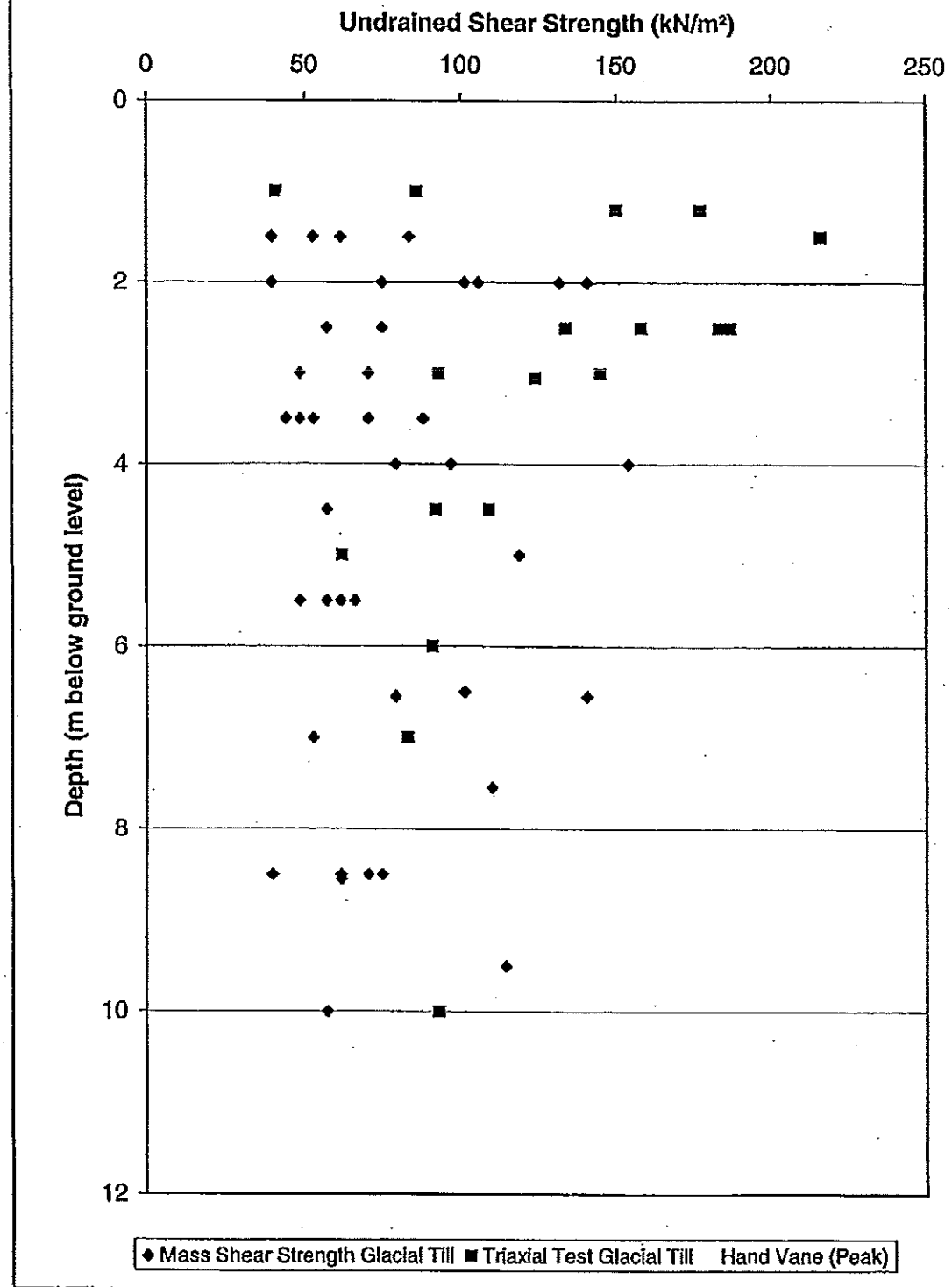


Title
Variation of N values with Depth

Mott MacDonald
1 Atlantic Quay
Broomielaw, Glasgow, G2 8JB
Tel: (0141) 222 4500

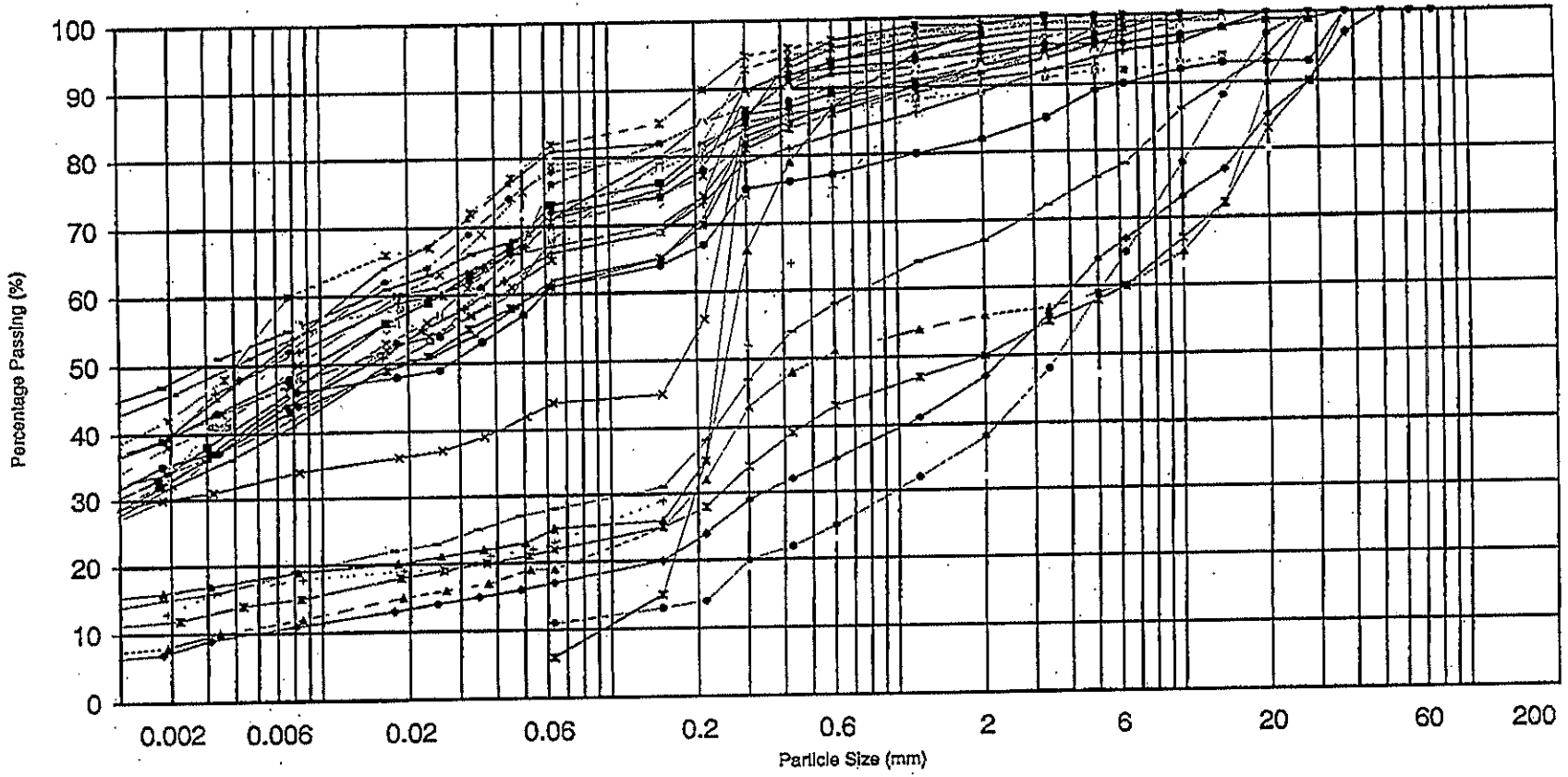
Project	Project No	Fig
Aldbrough Gas Storage Facility	208202	A.9
Client	Report No	Rev
Scottish and Southern Energy	208202/GLA	A



Title
Variation of Shear Strength with Depth within Glacial Deposits

Mott MacDonald
1 Atlantic Quay
Broomielaw, Glasgow, G2 8JB
Tel: (0141) 222 4500

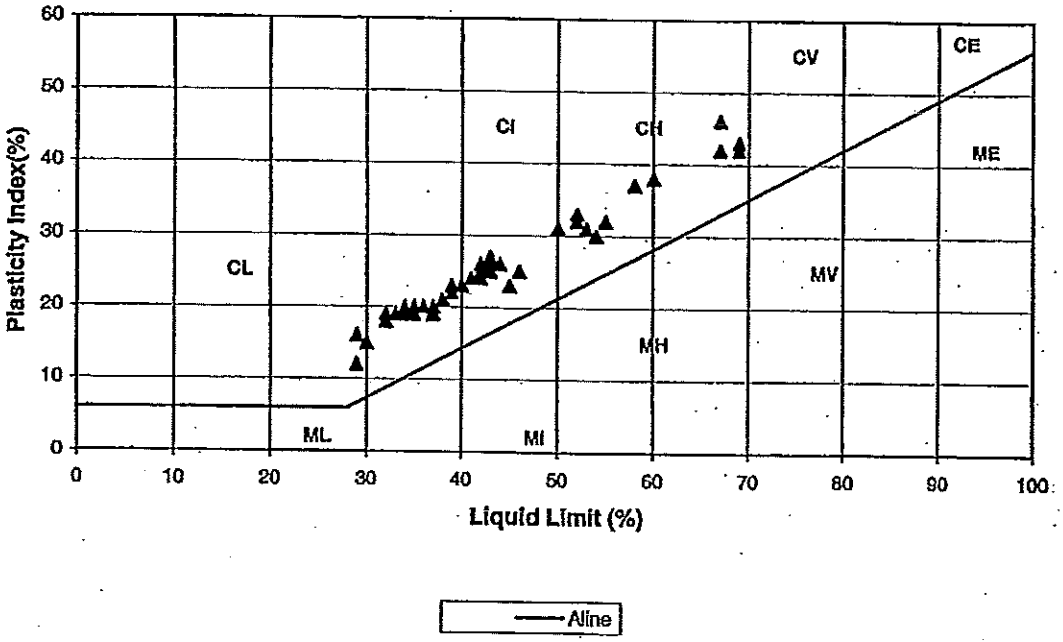
Project	Project No	Fig
Aldbrough Gas Storage Facility	208202	A.10
Client	Report No	Rev
Scottish and Southern Energy plc	208202/GLA	A



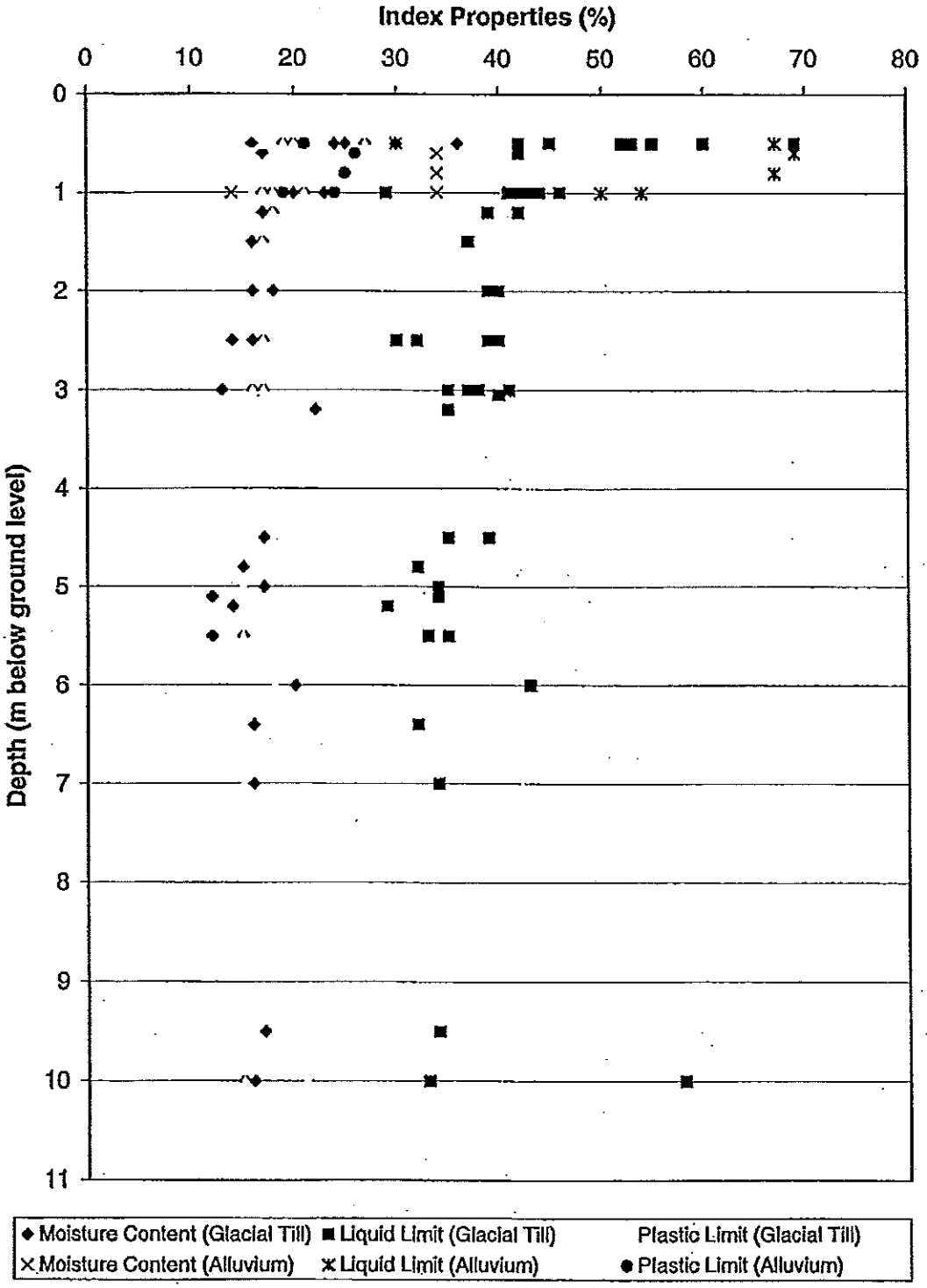
Title
Particle Size Distribution Curve

Mott MacDonald
1 Atlantic Quay
Broomielaw, Glasgow, G2 8JB
Tel: (0141) 222 4500

Project	Project No	Fig
Aldbrough Gas Storage Facility	208202	A.11
Client	Report No	Rev
Scottish and Southern Energy plc	208202/GLA	A



Title: Plasticity Chart for Glacial Till	Mott MacDonald, 1 Atlantic Quay, Broomielaw, Glasgow, G2 8JB, Tel: (0141) 222 4500	
Project: Aldbrough Gas Storage Facility Client: Scottish and Southern Energy Plc	Project No: 208202 Report No: 208202/GLA	Fig: A.12 Rev: A

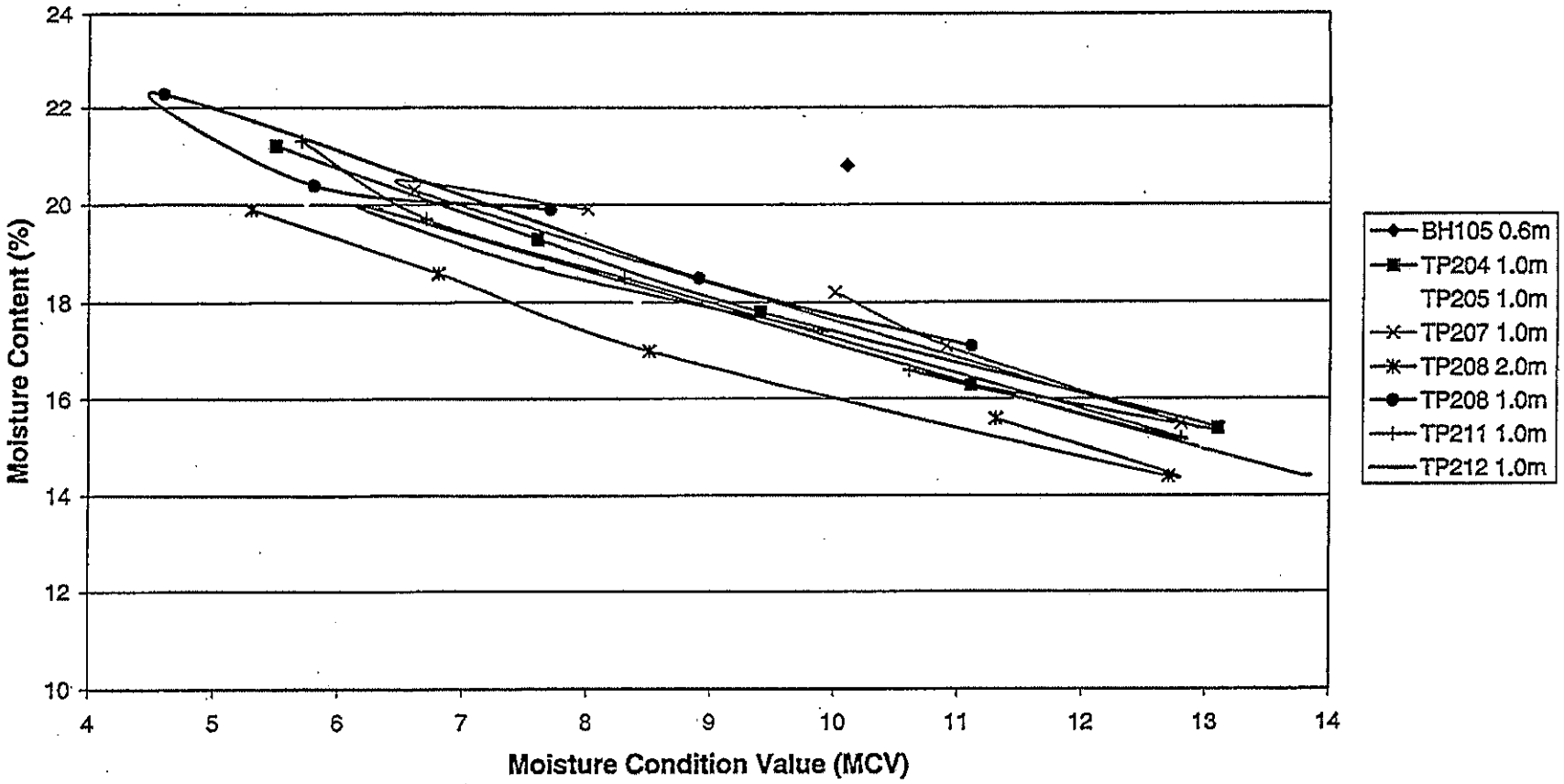


Title

Variation of Index Properties of Glacial Till and Alluvium with Depth

Mott MacDonald
1 Atlantic Quay
Broomielaw, Glasgow, G2 8JB
Tel: (0141) 222 4500

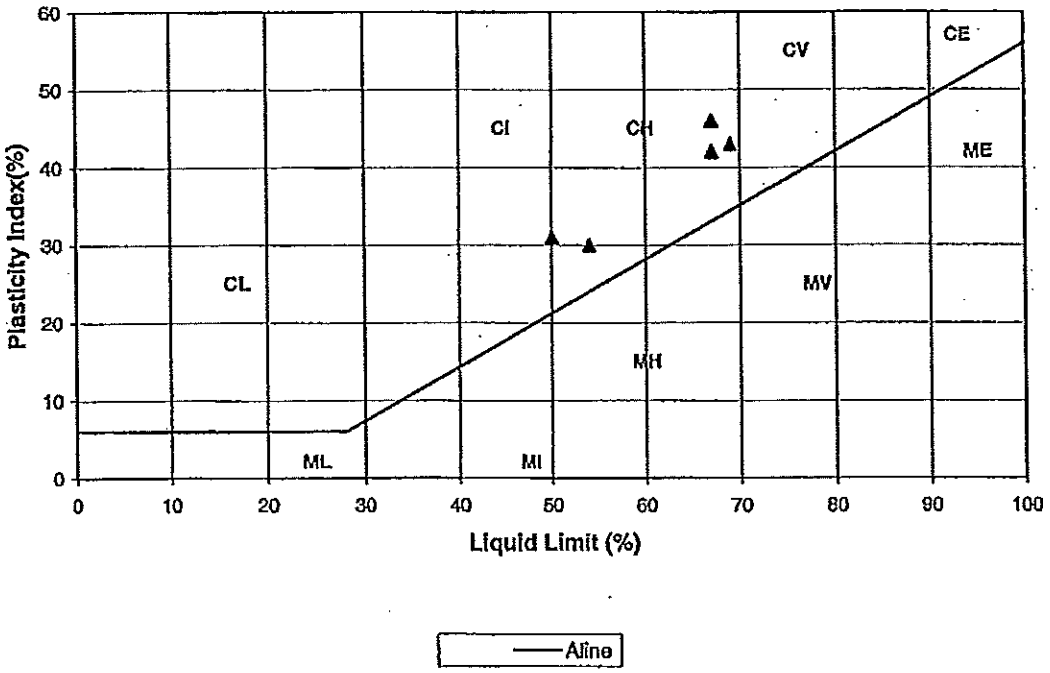
Project	Project No	Fig
Aldbrough Gas Storage Facility	208202	A.13
Client	**Report No**	**Rev**
Scottish and Southern Energy plc	208202/GLA	A



Title
Moisture Condition Calibration Line

Mott MacDonald
1 Atlantic Quay
Broomielaw, Glasgow, G2 8JB
Tel: (0141) 222 4500

Project	Project No	Fig
Aldbrough Gas Storage facility	208202	A.14
Client	Report No	Rev
Scottish and Southern Energy plc	208202/A	A



Title: Plasticity Chart for Alluvium	Mott MacDonald, 1 Atlantic Quay, Broomielaw, Glasgow, G2 8JB, Tel: (0141) 222 4500	
Project: Aldbrough Gas Storage Facility	Project No: 208202	Fig: A.15
Client: Scottish and Southern Energy plc	Report No: 208202/GLA	Rev: A

APPENDIX B

Envirocheck®
A Landmark® product

Envirocheck® Report

Datasheet

Report on:
Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire

National Grid Reference :
526060, 436980

Prepared For :
MOTT MACDONALD
1 Atlantic Quay
Robertson Street
GLASGOW
Lanarkshire
G2 8JB

Client Details:
Scottish and Southern Energy plc

Your Reference:
MR S Guasti,HCG0PUME01

Contents

Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination. For this reason, Landmark's Site Sensitivity Datasheet places great emphasis on statutory data provided by the Environment Agency and the Scottish Environment Protection Agency; it also incorporates data from English Nature (and the Scottish and Welsh equivalents), the Environment Agency (and the Scottish equivalent) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the legend database to 1km from a single point or a site boundary provided by the client

In the attached datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers

Copyright Notice

Data Type	On Site	0 to 250m	251 to 500m	501 to 1000m (Up to 2000m)
Agency & Hydrological				
Air Pollution Controls				
Air Pollution Control Enforcements				
Contaminated Land Register Entries and Notices				
Discharge Consents			1	
Enforcement and Prohibition Notices				
Integrated Pollution Controls				
Integrated Pollution Prevention And Control				
Nearest Surface Water Feature		Yes		
Pollution Incidents to Controlled Waters				
Substantiated Pollution Incident Register				
Prosecutions Relating to Authorised Processes				
Prosecutions Relating to Controlled Waters				
Red List Discharge Consents				
Registered Radioactive Substances				
River Quality				
River Quality Biology Sampling Points				
River Quality Chemistry Sampling Points				
Water Abstractions				(*1)
Groundwater Vulnerability	Yes			
Fluvial Indicative Floodplains				
Tidal Indicative Floodplains				
Source Protection Zones				
River Flood Data (Scotland)				
Waste				
BGS Recorded Landfill Sites				
Integrated Pollution Control Registered Waste Sites				
Licensed Waste Management Facilities (Landfill Boundaries)				
Licensed Waste Management Facilities (Locations)				
Local Authority Recorded Landfill Sites				
Registered Landfill Sites				
Registered Waste Transfer Sites				
Registered Waste Treatment or Disposal Sites				

Data Type	On Site	0 to 250m	251 to 500m	501 to 1000m (up to 2000m)
Hazardous Substances				
Control of Major Accident Hazards Sites (COMAH)				
Explosive Sites				
Notification of Installations Handling Hazardous Substances (NIHHS)				
Planning Hazardous Substance Consents				
Planning Hazardous Substance Enforcements				
Geological				
BGS Boreholes		1	1	2
BGS Recorded Mineral Sites				
BGS 1:625,000 Solid Geology	Yes			
Brine Compensation Areas				
Coal Mining Affected Areas				
Shallow Mining Hazards				
Compressible Ground Subsidence Hazards		Yes		
Ground Dissolution Subsidence Hazards				
Gulls And Cambering Subsidence Hazards				
Landslip Subsidence Hazards				
Swelling Clay Subsidence Hazards				
Mining Instability				
Natural and Mining Cavities				
Radon Affected Areas	Yes			
Radon Protection Measures	Yes			
Industrial Land Use				
Contemporary Trade Directory Entries				
Fuel Station Entries				

Data Type / Sensitive Land Uses	On Site	0 to 250m	251 to 500m	501 to 1000m (1dp to 2000m)
Areas of Adopted Green Belt				
Areas of Unadopted Green Belt				
Areas of Outstanding Natural Beauty				
Environmentally Sensitive Areas				
Forest Parks				
Local Nature Reserves				
Marine Nature Reserves				
National Nature Reserves				
National Parks				
National Scenic Areas				
Nitrate Sensitive Areas				
Nitrate Vulnerable Zones	1			
Ramsar Sites				
Sites of Special Scientific Interest				
Special Areas of Conservation				
Special Protection Areas				

Map ID	Details		Compass Direction	Estimated Distance From Site	Contact	Grid Ref
	Discharge Consents					
1	Operator:	Aldbrough Gas Storage Company, Ltd	S	282	1	526160 436720
	Property Type:	Undefined Or Other				
	Location:	Land East Of Aldbrough Road,Garton,East Yorkshire,Uk				
	Authority:	Environment Agency, North East Region				
	Catchment Area:	North Sea				
	Reference:	Wra7377				
	Permit Version:	1				
	Effective Date:	3rd December 1997				
	Issued Date:	3rd December 1997				
	Revocation Date:	Not Supplied				
	Discharge Type:	Trade Effluent				
	Discharge Environment:	Controlled Sea				
	Receiving Water:	North Sea				
	Status:	New Consent (Water Resources Act 1991, Section 88 & Schedule 10 as amended by Environment Act 1995)				
	Positional Accuracy:	Located by supplier to within 10m				
	Water Abstractions					
	Operator:	M S Meadley	E	1165	1	52720(43720
	Licence Number:	2/26/33/001				
	Permit Version:	100				
	Location:	Borehole - Chalk - Aldbrough				
	Authority:	Environment Agency, North East Region				
	Abstraction:	General Farming And Domestic				
	Abstraction Type:	Water may be abstracted from a single point				
	Source:	Groundwater				
	Daily Rate (m3):	5				
	Yearly Rate (m3):	1659				
	Details:	Ringborough Farm,East Newton,Aldborough,Hull				
	Authorised Start:	01 January				
	Authorised End:	31 December				
	Permit Start Date:	1st December 1965				
	Permit End Date:	Not Supplied				
	Positional Accuracy:	Located by supplier to within 10m				
	Groundwater Vulnerability					
	Geological Classification:	Non Aquifer (Negligibly permeable) - Formations which are generally regarded as containing insignificant quantities of groundwater. However, groundwater flow through such rocks, although imperceptible, does take place and needs to be considered in assessing the risk associated with persistent pollutants	-	0	2	526060 436980
	Soil Classification:	Not classified				
	Map Sheet:	Sheet 13 Humber Estuary				
	Scale:	1:100,000				
	Drift Deposits					
	Description	None	-	-	-	-
	Fluvial Indicative Floodplains					
	Description	None	-	-	-	-
	Tidal Indicative Floodplains					
	Description	None	-	-	-	-
	River Flood Data (Scotland)					
	Description	None	-	-	-	-

Map Key	Details	Compass Direction	Estimated Distance From Site	Contact	NGR
Local Authority Landfill Coverage					
Name:	East Riding of Yorkshire Unitary Authority - Has no landfill data to supply to Landmark	-	0	3	526060 436980

Map ID	Details	Compass Direction	Estimated Distance From Site	Contact	NGR
	BGS Boreholes				
3	BGS Reference: Ta23ne2/B Drilled Length (m): 18.28 Borehole Name: Holdness North (Srs) (Bp 66) 2071	SW	234	4	525840 436890
	BGS Boreholes				
4	BGS Reference: Ta23ne2/C Drilled Length (m): 18.28 Borehole Name: Holdness North (Srs) (Bp 66) 2072	E	322	4	526370 436910
	BGS Boreholes				
5	BGS Reference: Ta23ne2/A Drilled Length (m): 18.28 Borehole Name: Holdness North (Srs) (Bp 66) 2070	W	726	4	525340 436860
	BGS Boreholes				
6	BGS Reference: Ta23ne2/D Drilled Length (m): 18.28 Borehole Name: Holdness North (Srs) (Bp 66) 2073	E	805	4	526860 436950
	BGS 1:625,000 Solid Geology				
	Description: Chalk including Red Chalk	-	0	5	526060 436980
	Coal Mining Affected Areas				
	Description: In an area which may not be affected by coal mining	-	-	-	-
	Shallow Mining Hazards				
	Description: No Hazard	-	-	-	-
	Compressible Ground Subsidence Hazards				
	Risk: Moderate-High Source: British Geological Survey, Information Services Group	S	104	5	526050 436880
	Ground Dissolution Subsidence Hazards				
	Description: No Hazard	-	-	-	-
	Gulls And Cambering Subsidence Hazards				
	Description: No Hazard	-	-	-	-
	Landslip Subsidence Hazards				
	Description: No Hazard	-	-	-	-
	Swelling Clay Subsidence Hazards				
	Description: No Hazard	-	-	-	-
	Radon Affected Areas				
	Description: Less than 1% of homes are above the Action Level Source: National Radiological Protection Board	-	0	6	526060 436980
	Radon Protection Measures				
	Type: No radon protective measures are necessary Source: British Geological Survey, Information Services Group	-	0	5	526060 436980

Map ID	Details	Compass Direction	Estimated Distance From Site		Contact / NGR
	Nitrate Vulnerable Zones				
	Name: Not Supplied	-	0	7	526060
	Area (m2): 2638970112				436980
	Source: Department for Environment, Food and Rural Affairs (DEFRA - formally from FRCA)				

Data Type	Version	Update Cycle
Agency & Hydrological		
Air Pollution Controls East Riding of Yorkshire Unitary Authority Planning Department	July-2002	Annual Rolling Update
Air Pollution Control Enforcements East Riding of Yorkshire Unitary Authority Planning Department	July-2002	Annual Rolling Update
Contaminated Land Register Entries and Notices East Riding of Yorkshire Unitary Authority Public Protection and Housing	April-2002	Annually
Discharge Consents Environment Agency North East Region	December-2002	Bi-Annually
Enforcement and Prohibition Notices Environment Agency North East Region	May-2003	As notified
Integrated Pollution Controls Environment Agency North East Region	May-2003	Quarterly
Integrated Pollution Prevention And Control Environment Agency North East Region	May-2003	Quarterly
Pollution Incidents to Controlled Waters Environment Agency North East Region	December-1998	Variable
Substantiated Pollution Incident Register Environment Agency - North East Region Ridings Area	December-2002	Bi-Annually
Prosecutions Relating to Authorised Processes Environment Agency North East Region	May-2003	As notified
Prosecutions Relating to Controlled Waters Environment Agency North East Region	May-2003	As notified
Red List Discharge Consents Environment Agency North East Region	May-2003	Quarterly
Registered Radioactive Substances Environment Agency North East Region	March-2003	Quarterly
River Quality Environment Agency Head Office	November-2001	Not Applicable
River Quality Biology Sampling Points Environment Agency Head Office	October-2002	Annually
River Quality Chemistry Sampling Points Environment Agency Head Office	November-2002	Annually
Water Abstractions Environment Agency North East Region	December-2002	Bi-Annually
Groundwater Vulnerability Environment Agency Head Office	January-1999	Not Applicable

Data Type	Version	Update Cycle
Agency & Hydrological		
Drift Deposits Environment Agency Head Office	January-1999	Not Applicable
Fluvial Indicative Floodplains Environment Agency Head Office	January-2003	Variable
Tidal Indicative Floodplains Environment Agency Head Office	January-2003	Variable
Source Protection Zones Environment Agency Head Office	February-2003	As notified
River Flood Data (Scotland) Centre for Ecology and Hydrology	September-1999	Not Applicable

Data Type	Version	Update Cycle
Waste		
BGS Recorded Landfill Sites British Geological Survey Information Services Group	June-1996	Not Applicable
Integrated Pollution Control Registered Waste Sites Environment Agency North East Region	May-2003	Quarterly
Licensed Waste Management Facilities (Landfill Boundaries) Environment Agency - North East Region Ridings Area	July-2002	Bi-Annually
Licensed Waste Management Facilities (Locations) Environment Agency - North East Region Ridings Area	November-2002	Bi-Annually
Local Authority Landfill Coverage East Riding of Yorkshire Unitary Authority	May-2000	Not Applicable
Registered Landfill Sites Environment Agency - North East Region Ridings Area	June-2002	Annual Rolling Update
Registered Waste Transfer Sites Environment Agency - North East Region Ridings Area	June-2002	Annual Rolling Update
Registered Waste Treatment or Disposal Sites Environment Agency - North East Region Ridings Area	June-2002	Annual Rolling Update

Data Type	Version	Update Cycle
Hazardous Substances		
Control of Major Accident Hazards Sites (COMAH) Health and Safety Executive	May-2001	Variable
Explosive Sites Health and Safety Executive	May-2003	Bi-Annually
Notification of Installations Handling Hazardous Substances (NIHHS) Health and Safety Executive	November-2000	Not Applicable
Planning Hazardous Substance Consents East Riding of Yorkshire Unitary Authority	November-2002	Annual Rolling Update
Planning Hazardous Substance Enforcements East Riding of Yorkshire Unitary Authority	November-2002	Annual Rolling Update

Data Type	Version	Update Cycle
Geological		
BGS Boreholes British Geological Survey National Geological Records Centre	January-2003	Bi-Annually
BGS Recorded Mineral Sites British Geological Survey Information Services Group	October-2002	Annually
BGS 1:625,000 Solid Geology British Geological Survey Information Services Group	August-1996	Not Applicable
Brine Compensation Areas Cheshire Brine Subsidence Compensation Board	November-2002	As notified
Coal Mining Affected Areas The Coal Authority Mining Report Service	December-2001	Not Applicable
Shallow Mining Hazards British Geological Survey Information Services Group	August-2002	Variable
Compressible Ground Subsidence Hazards British Geological Survey Information Services Group	August-2002	Variable
Ground Dissolution Subsidence Hazards British Geological Survey Information Services Group	August-2002	Variable
Gulls And Cambering Subsidence Hazards British Geological Survey Information Services Group	August-2002	Variable
Landslip Subsidence Hazards British Geological Survey Information Services Group	August-2002	Variable
Swelling Clay Subsidence Hazards British Geological Survey Information Services Group	August-2002	Variable
Mining Instability Ove Arup & Partners	October-2000	Not Applicable
Natural and Mining Cavities Peter Brett Associates Consulting Engineers	October-2001	Not Applicable
Radon Affected Areas National Radiological Protection Board	September-1999	Not Applicable
Radon Protection Measures British Geological Survey Information Services Group	August-2002	Variable

Data Type	Version	Update Cycle
Industrial Land Use		
Contemporary Trade Directory Entries Thomson Directories	February-2003	Bi-Annually
Fuel Station Entries Catalist Ltd (Fuel Station Data)	May-2003	Quarterly

Data Type	Version	Update Cycle
Sensitive Land Uses		
Areas of Outstanding Natural Beauty The Countryside Agency	September-2000	Not Applicable
Environmentally Sensitive Areas Department for Environment, Food and Rural Affairs (DEFRA - formally from FRCA)	January-2003	As Designated
Forest Parks Forestry Commission	April-1997	As Designated
Local Nature Reserves East Riding of Yorkshire Unitary Authority Planning Department	September-1999	As notified
Marine Nature Reserves English Nature	December-2002	Bi-Annually
National Nature Reserves English Nature	December-2002	Bi-Annually
National Parks The Countryside Agency	October-2000	As Designated
Nitrate Sensitive Areas Department for Environment, Food and Rural Affairs (DEFRA - formally from FRCA)	January-2000	As Designated
Nitrate Vulnerable Zones Department for Environment, Food and Rural Affairs (DEFRA - formally from FRCA)	November-2002	As Designated
Ramsar Sites English Nature	December-2002	Bi-Annually
Sites of Special Scientific Interest English Nature	December-2002	Bi-Annually
Special Areas of Conservation English Nature	December-2002	Bi-Annually
Special Protection Areas English Nature	December-2002	Bi-Annually

Some of the organisations who provide data which is used within the report

Ordnance Survey	Ordnance Survey® Licensed Partner
Environment Agency	ENVIRONMENT AGENCY
Scottish Environment Protection Agency	SEPA Scottish Environment Protection Agency
The Coal Authority	The COAL AUTHORITY
British Geological Survey	British Geological Survey Value Added Reseller
Centre for Ecology and Hydrology	Centre for Ecology & Hydrology NATURAL ENVIRONMENT RESEARCH COUNCIL
Countryside Council for Wales	CYNGOR CEFN GWLAD CYMRU COUNTRYSIDE COUNCIL FOR WALES
Scottish Natural Heritage	SCOTTISH NATURAL HERITAGE
English Nature Site of Special Scientific Interest, National Nature Reserve, Ramsar, Special Protection Area, Special Conservation Area, Marine Nature Reserve data (derived from Ordnance Survey 1:10000 raster) is provided by, and used with the permission of, English Nature who retain the copyright and Intellectual Property Rights for the data	ENGLISH NATURE
National Radiological Protection Board	NRPB
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Contact	Name and Address	
1	**Environment Agency North East Region** Rivers House 21 Park Square South Leeds West Yorkshire LS1 2QG	Telephone 0113 244 0191 Fax 0113 231 2375
2	**Environment Agency Head Office** Rio House Waterside Drive Aztec West, Almondsbury Bristol Avon BS32 4UD	Telephone 01454 624411 Fax 01454 624409
3	**East Riding of Yorkshire Unitary Authority** County Hall Beverley East Riding Yorkshire HU10 9BA	Telephone 01482 887700 Fax 01482 885414
4	**British Geological Survey National Geological Records Centre** Keyworth Nottingham Nottinghamshire NG12 5GG ngis@bgs.ac.uk www.bgs.ac.uk	Telephone 0115 936 3109 Fax 0115 936 3276
5	**British Geological Survey Information Services Group** Kingsley Dunham Centre Keyworth Nottingham Nottinghamshire NG12 5GG www.bgs.ac.uk	Telephone 0115 936 3100 Fax 0115 936 3200

Contact	Name and Address	
6	**National Radiological Protection Board** Chilton Didcot Oxfordshire OX11 0RQ	Telephone 01235 831600 Fax 01235 833891
7	**Department for Environment, Food and Rural Affairs (DEFRA - formally from FRCA)** Government Buildings Otley Road Lawnswood Leeds West Yorkshire LS16 5QT	Telephone 0113 2613333 Fax 0113 230 0879

Contact	Name and Address	
	Catalist Ltd (Fuel Station Data) Richmond House 22 Richmond Hill Clifton Bristol Avon BS8 1BA Mark@catalist-uk.com	Telephone 0117 923 7113 Fax 0117 923 7166
	The Coal Authority Mining Report Service 200 Lichfield Lane Mansfield Nottinghamshire NG18 4RG thecoalauthority@coal.gov.uk	Telephone 0845 7626848 DX 716176 Mansfield 5
	Landmark Information Group Limited 6 - 7 Abbey Court Eagle Way Sowton Exeter Devon EX2 7HY mailbox@landmark-information.co.uk www.landmark-information.co.uk	Telephone 01392 441702 Fax 01392 441709

Please note that the Environment Agency/SEPA have a charging policy in place for enquiries

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ref no: ISGR/...../.....

Your ref/order no. (if required): .....

Value Added Reseller

BOREHOLE RECORDS ORDER FORM

Please note this order form is only to be used for the supply of borehole records from the National Geological Records Centre (NGRC) identified from Landmark Reports

Name:-
Address:-

Company:-

Telephone Number:-

Fax Number:-

Date:-

With repect to the following boreholes I would like to: -

Enquire about the costs [] Purchase copies [] New Leaflet []

BGS Registration number:			
Quarter Sheet	Number	Suffix	Name

Note: More than 10 records can be ordered, but it is advisable to discuss your requirements first with NGRC staff

Unit price £13(+VAT) per borehole. Minimum charge £26(+VAT)

Method of delivery, please indicate preferred option.

1st class post [] Special delivery (guaranteed next day before 12:30pm.) [] Fax []
(Note 1st. class postage is included in the unit charge. Additional charges are made for fax or special delivery)

Please return this form to: - The Records Officer, National Geological Records Centre, British Geological Survey, Keyworth, Nottingham, NG12 5GG. Tel: 0115936 3109 Fax: 0115936 3276
E-mail: ngis@bgs.ac.uk

Envirocheck®
A Landmark® product

Envirocheck® Report:

Historical Map List

Report on:

Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire

National Grid Reference :

526060, 436980

Prepared For :

Mott Macdonald
12208
1 Atlantic Quay
Robertson Street
Glasgow
LanarkshireG2 8JB

Client Details:

Scottish and Southern Energy plc

Your Reference

MR S Guasti,HCG0PUME01

Ordnance Survey County Series Published 1889 to 1891

County	Mapsheet	Scale	Year
Yorkshire	213_13	1:2,500	1889
Yorkshire	213_14	1:2,500	1891

Ordnance Survey County Series Published 1910

County	Mapsheet	Scale	Year
Yorkshire	213_13	1:2,500	1910
Yorkshire	213_14	1:2,500	1910

Ordnance Survey County Series Published 1927

County	Mapsheet	Scale	Year
Yorkshire	213_13	1:2,500	1927
Yorkshire	213_14	1:2,500	1927

Ordnance Survey Plan Published 1975 to 1976

National Grid Series	Mapsheet	Scale	Year
Ordnance Survey Plan	TA2536	1:2,500	1976
Ordnance Survey Plan	TA2537	1:2,500	1976
Ordnance Survey Plan	TA2636	1:2,500	1975
Ordnance Survey Plan	TA2637	1:2,500	1976

Ordnance Survey County Series Published 1855

County	Mapsheet	Scale	Year
Yorkshire	213_00	1:10,560	1855
Yorkshire	228_00	1:10,560	1855

Ordnance Survey County Series Published 1892

County	Mapsheet	Scale	Year
Yorkshire	213_SW	1:10,560	1892
Yorkshire	228_NW	1:10,560	1892

Ordnance Survey County Series Published 1910

County	Mapsheet	Scale	Year
Yorkshire	213_SW	1:10,560	1910
Yorkshire	228_NW	1:10,560	1910

Ordnance Survey County Series Published 1951 to 1952

County	Mapsheet	Scale	Year
Yorkshire	213_SW	1:10,560	1952
Yorkshire	228_NW	1:10,560	1951

Ordnance Survey Plan Published 1956

National Grid Series	Mapsheet	Scale	Year
Ordnance Survey Plan	TA23NE	1:10,560	1956
Ordnance Survey Plan	TA23NW	1:10,560	1956

Ordnance Survey Plan Published 1978

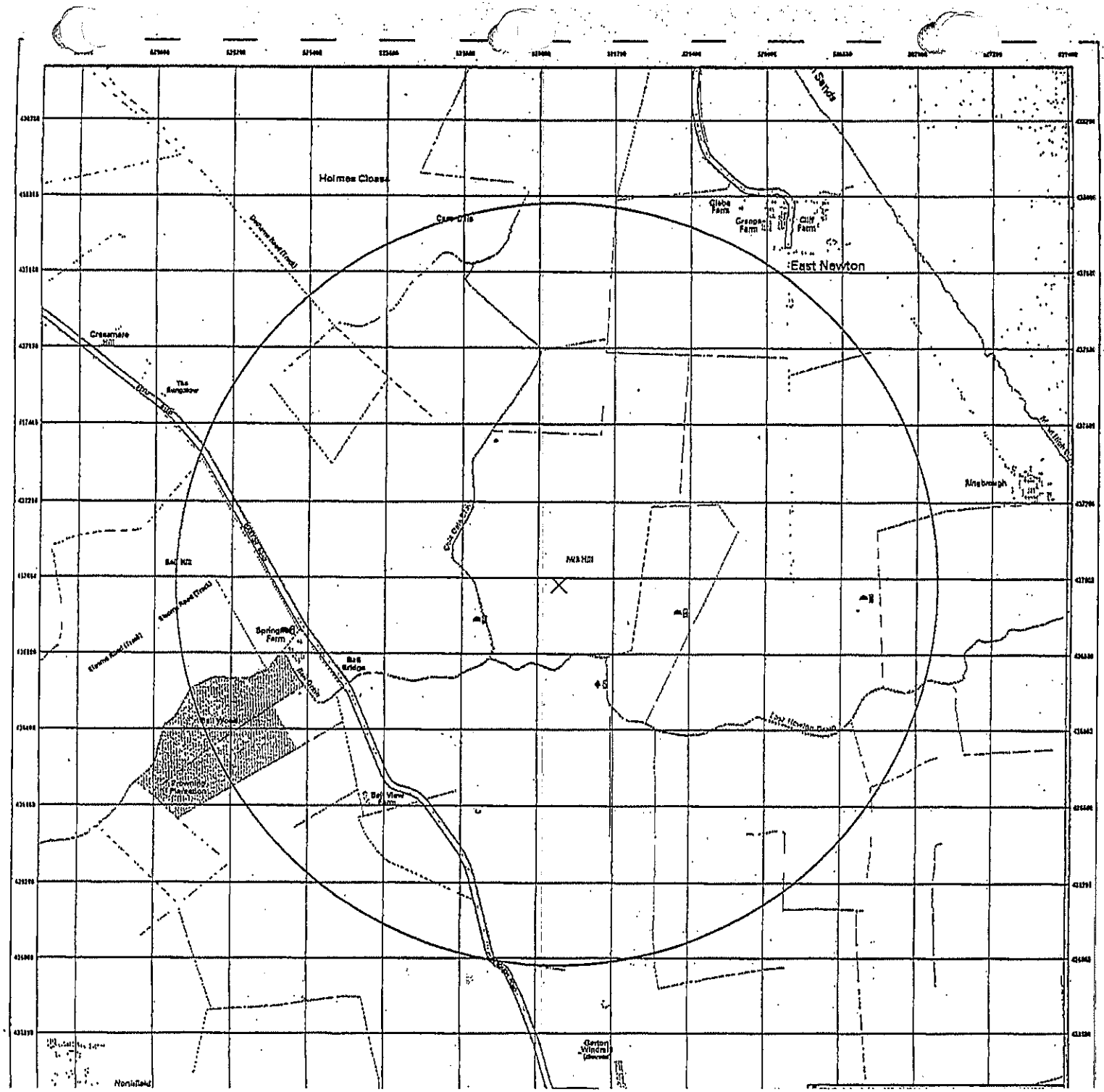
National Grid Series	Mapsheet	Scale	Year
Ordnance Survey Plan	TA23NE	1:10,000	1978
Ordnance Survey Plan	TA23NW	1:10,000	1978

Ordnance Survey Plan Published 1978

National Grid Series	Mapsheet	Scale	Year
Ordnance Survey Plan	TA23NE	1:10,000	1978
Ordnance Survey Plan	TA23NW	1:10,000	1978

Ordnance Survey Plan Published 1999

	Mapsheet	Scale	Year
Ordnance Survey Plan	TA23NE	1:10,000	1999
Ordnance Survey Plan	TA23NW	1:10,000	1999



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A Landmark® product

CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

SITE DETAILS Grid Reference 526080 436980

Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire

KEY TO THE LEGEND DATABASE

General

- Specified Site
- Bearing Reference Point
- Buffer (1000m)
- Reference Number
- Several of Type at Location

Agency and Hydrological

- Air Pollution Control
- Air Pollution Control Enforcement
- Point Location of Contaminated Land Register Entry or Notice
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement Or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Pollution Incident to Controlled Waters
- Substantiated Pollution Incident Register
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Red List Discharge Consent
- Registered Radioactive Substance
- River Quality Sampling Point
- Water Abstraction

Waste

- Point Location of BGS Recorded Landfill Site
- BGS Recorded Landfill Site
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facilities (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Point Location of Local Authority Recorded Landfill Site
- Local Authority Recorded Landfill Site
- Registered Landfill Site
- Point Location of Registered Waste Transfer Site
- Registered Waste Transfer Site
- Point Location of Registered Waste Treatment or Disposal Site
- Registered Waste Treatment or Disposal Site

Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

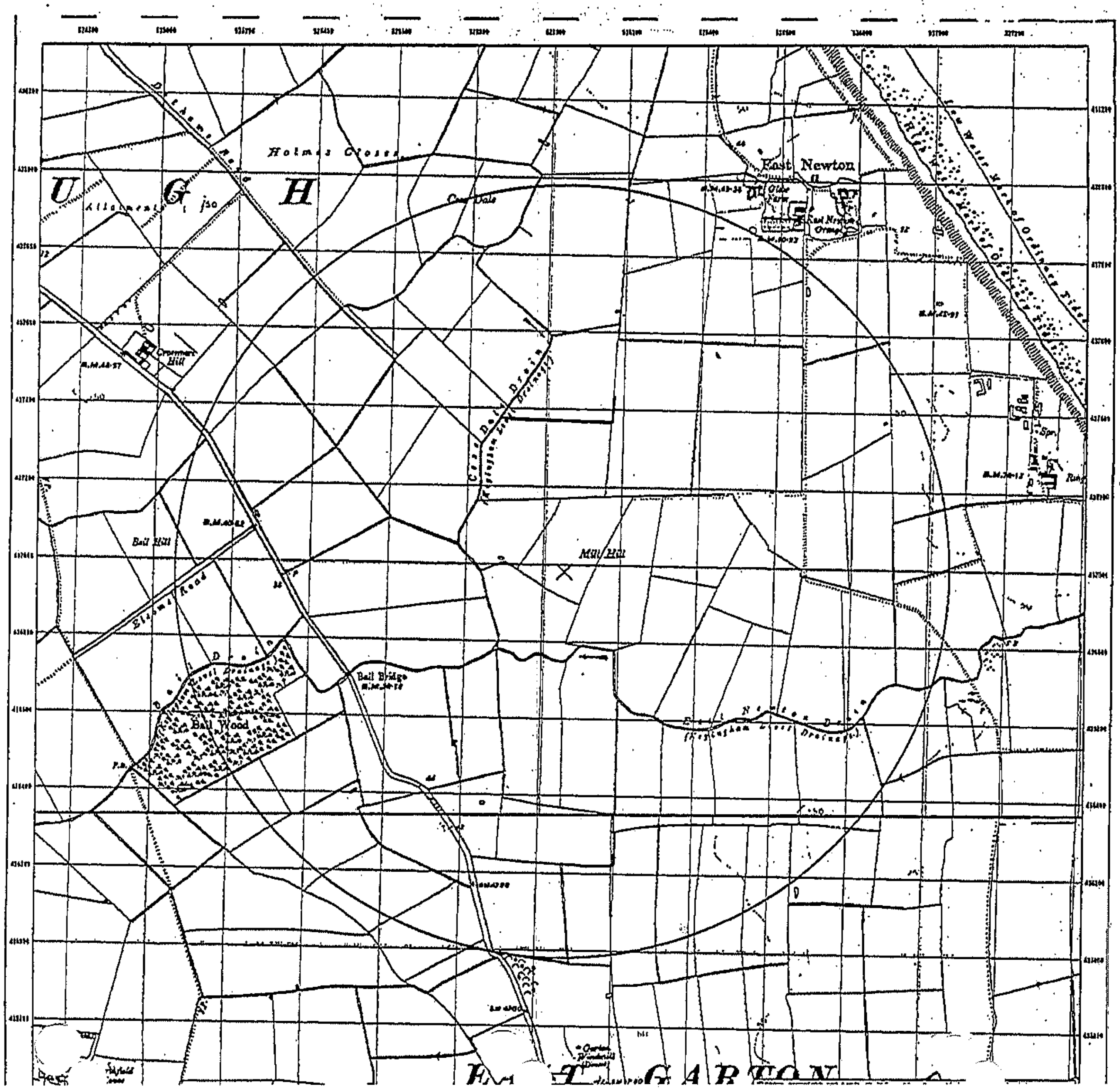
Geological

- BGS Borehole
- BGS Recorded Mineral Site

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry

ENVIRONMENT · British Geological Survey · Ordnance Survey



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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

SITE DETAILS Grid Reference 526080 436980

Aldbrough Gas Storage Facility
Aldbrough
East Riding

Yorkshire

Historical Map Legend

Quarry | Shingle | Railway over Road | Road over Railway
Gravel Pit | Sand Pit | Level Crossing | Railway over River
Other Pits | Road over Stream | Road over Stream
Rough Pasture | Furze | Road over River or Canal
Marsh | Reeds | Sunken Road | Raised Road
Osiers | Instrumental Contour
Arrow denotes flow of Water | Sketched Contour

YORKSHIRE

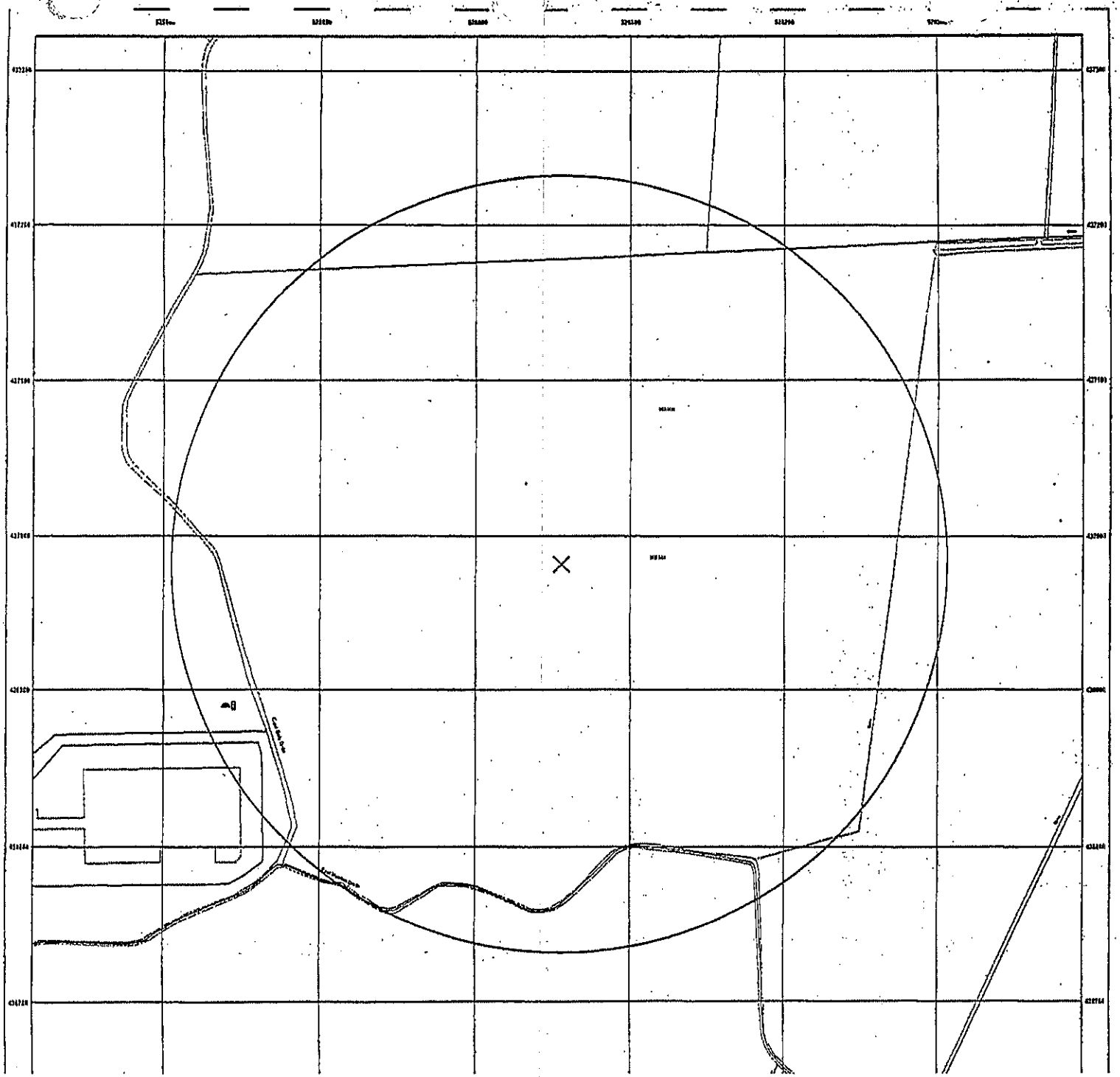
[illegible]

Date(s) of Publication

1952

1961

Ordnance Survey® LANDMARK®



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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

SITE DETAILS Grid Reference 526060 436980

Aldbrough Gas Storage Facility
Aldbrough
East Riding

Yorkshire

KEY TO THE LEGEND DATABASE

General

- Specified Site
- Bearing Reference Point
- Buffer (250m)
- Reference Number
- Several of Type at Location
- Pylon
- Overhead Transmission Line

Agency and Hydrological

- Air Pollution Control
- Air Pollution Control Enforcement
- Point Location of Contaminated Land Register Entry or Notice
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement Or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Pollution Incident to Controlled Waters
- Substantiated Pollution Incident Register
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Red List Discharge Consent
- Registered Radioactive Substance
- River Network or Water Feature
- River Quality Sampling Point
- Water Abstraction

Waste

- Point Location of BGS Recorded Landfill Site
- BGS Recorded Landfill Site
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facilities (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Point Location of Local Authority Recorded Landfill Site
- Local Authority Recorded Landfill Site
- Registered Landfill Site
- Point Location of Registered Waste Transfer Site
- Registered Waste Transfer Site
- Point Location of Registered Waste Treatment or Disposal Site
- Registered Waste Treatment or Disposal Site

Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

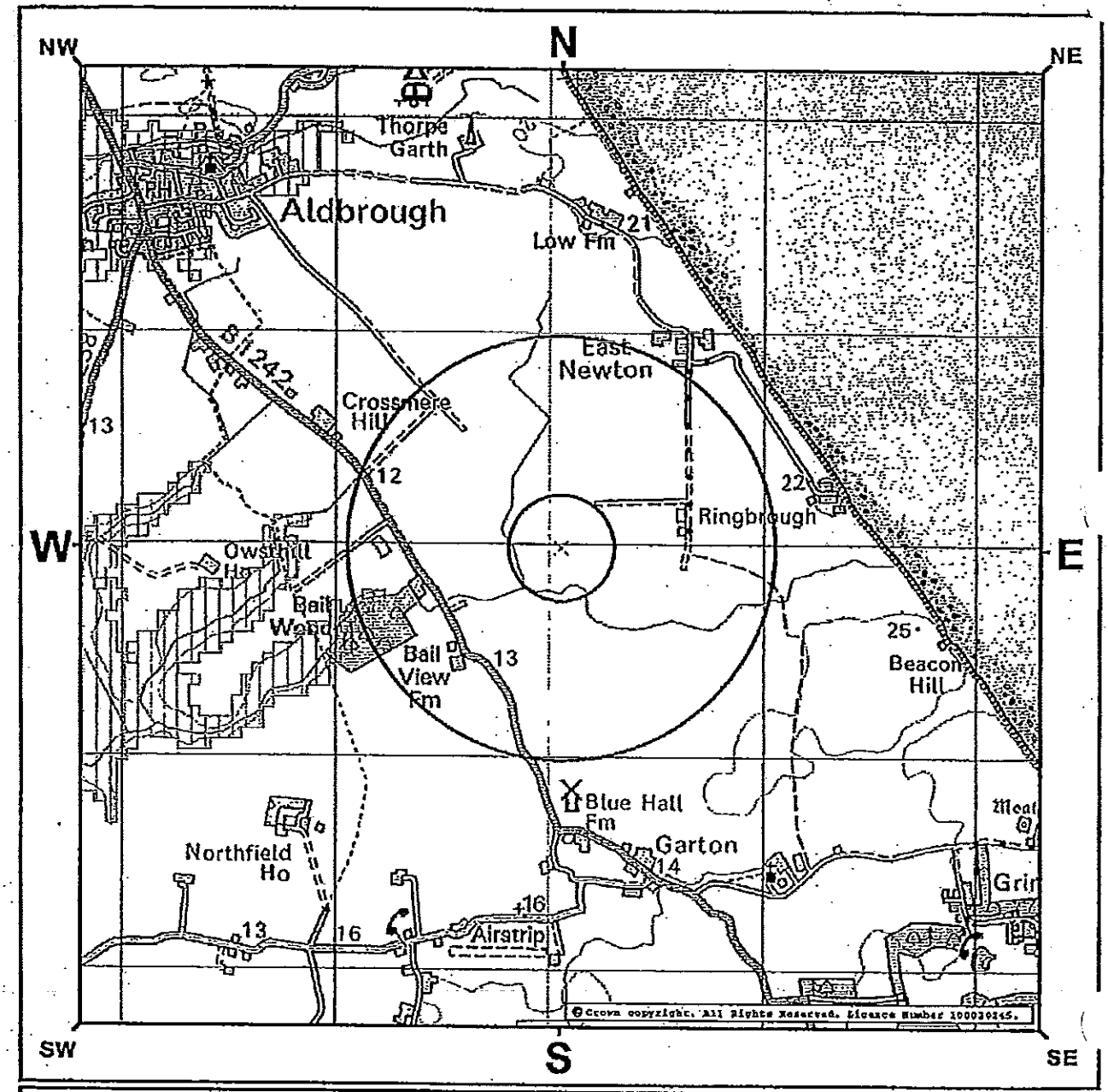
Geological

- BGS Borehole
- BGS Recorded Mineral Site

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry

ENVIRONMENT | British Geological Survey | Ordnance Survey



KEY

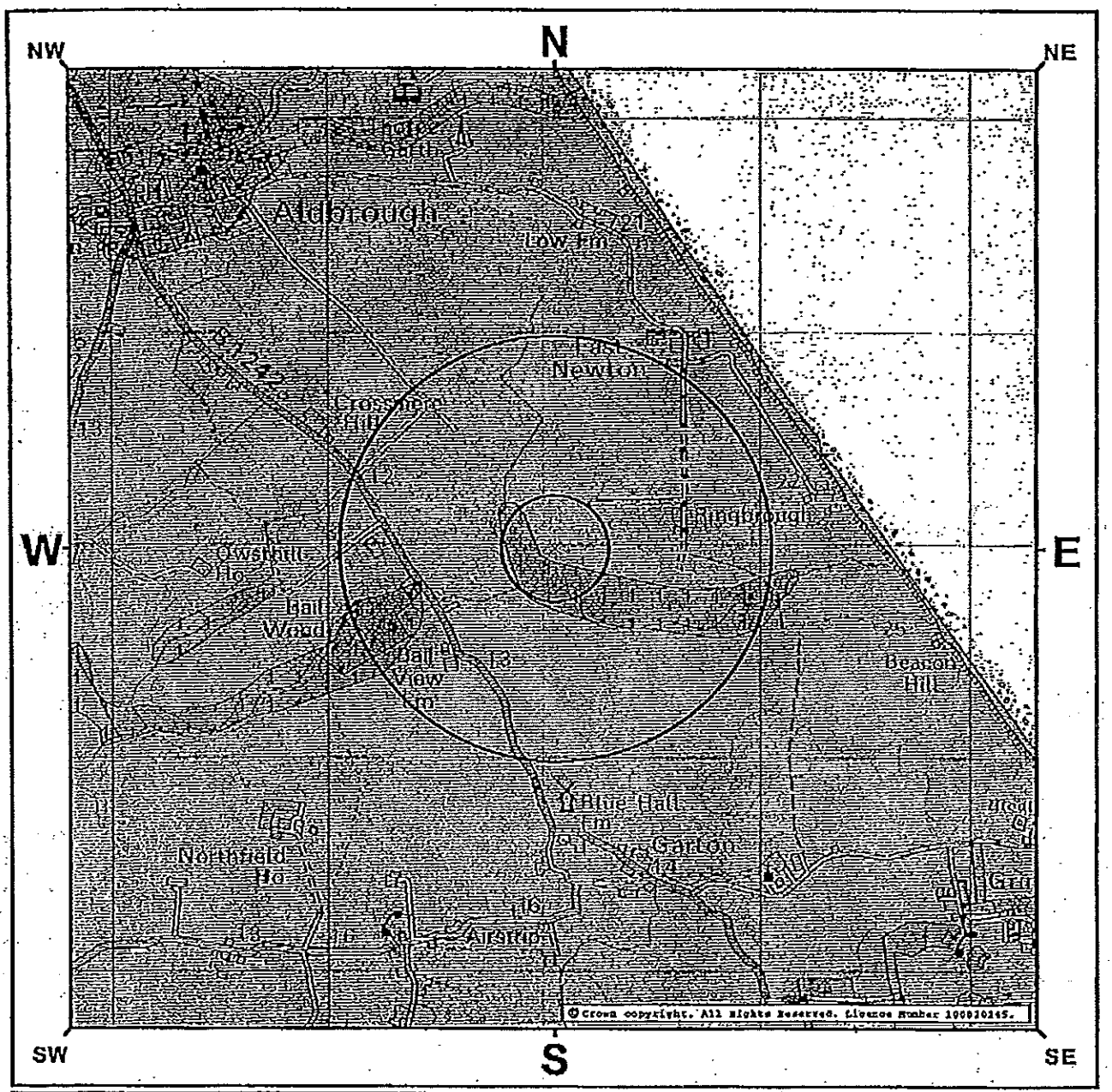
General

- Specified Site
- Bearing Reference Point
- Buffer

Agency & Hydrological

Environment Agency Indicative Floodplain

- Indicative Fluvial Floodplain
- Indicative Tidal Floodplain



KEY

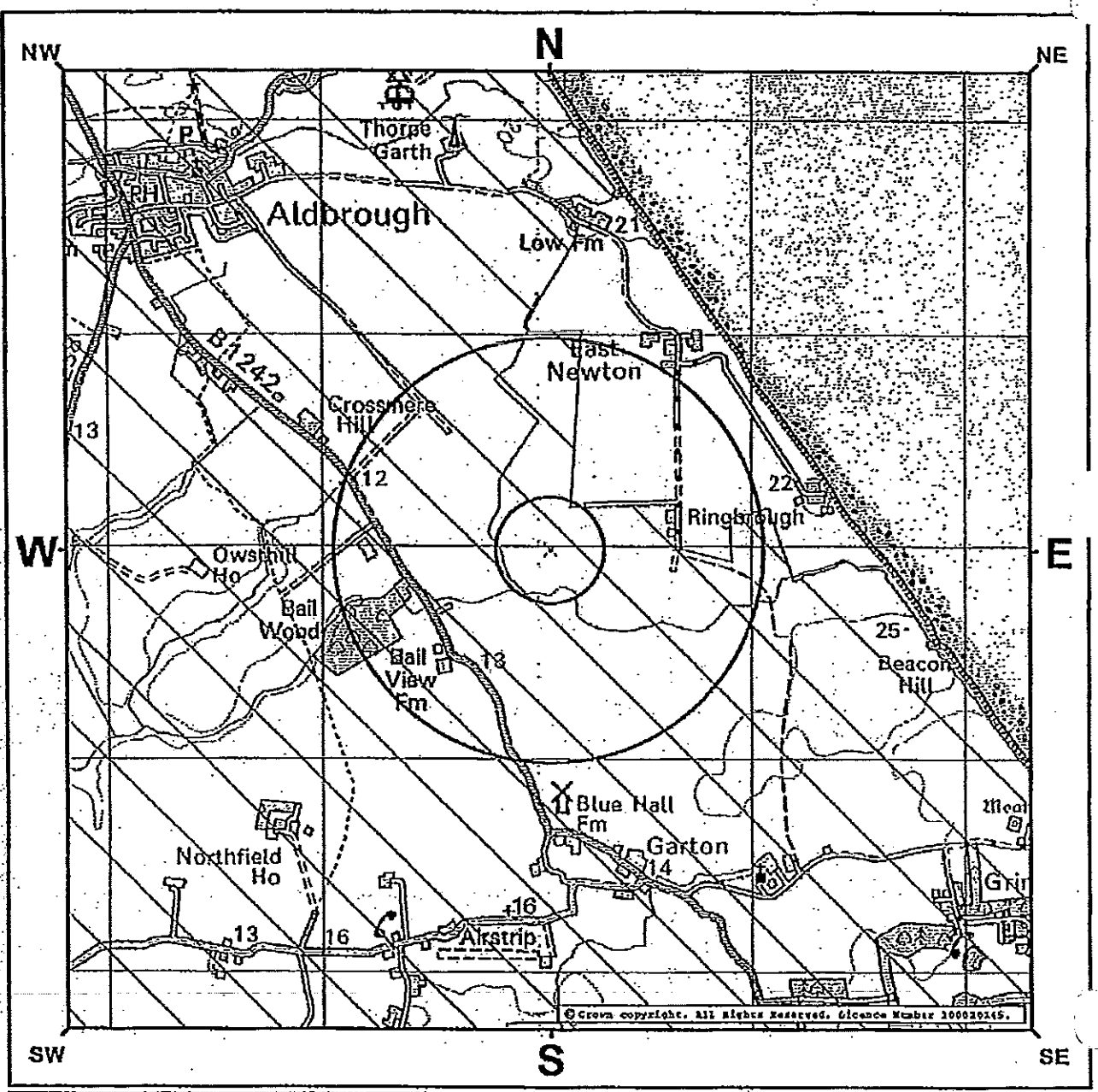
General

- Specified Site
- Bearing Reference Point
- Buffer

Groundwater Vulnerability

Geological Classes		Soil Classes
Major Aquifer (High Permeable)		High (H) 1, 2, 3, U
		Intermediate (I) 1, 2
		Low
Minor Aquifer (Variable Permeable)		High (H) 1, 2, 3, U
		Intermediate (I) 1, 2
		Low
Non Aquifer (Negligibly Permeable)		

Drift Deposit



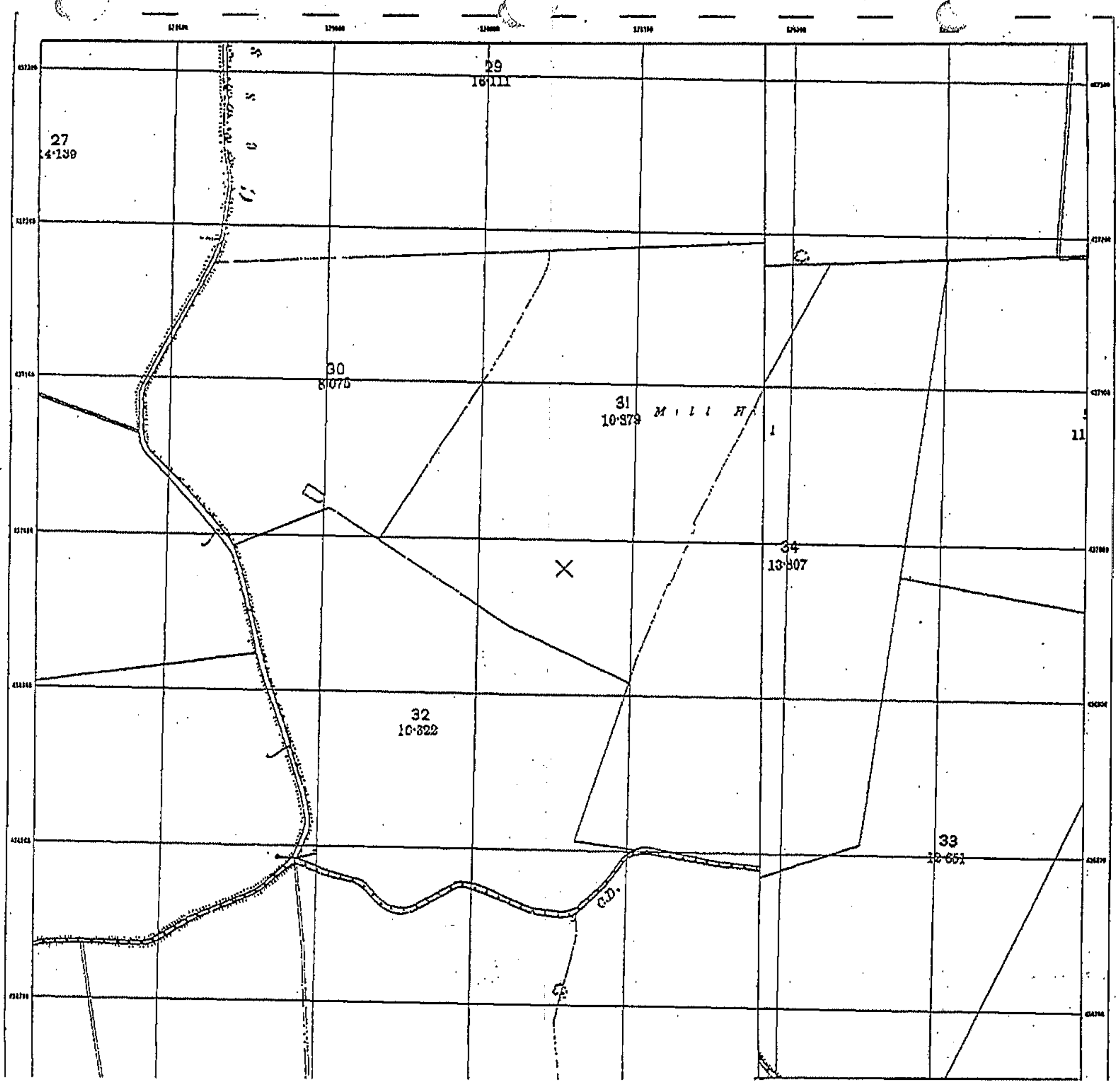
KEY

General

- Specified Site
- Bearing Reference Point
- Buffer

Sensitive Land Uses

- Area of Adopted Green Belt
- Area of Unadopted Green Belt
- Area of Outstanding Natural Beauty
- Environmentally Sensitive Area
- Forest Park
- Local Nature Reserve
- Marine Nature Reserve
- National Nature Reserve
- National Park
- National Scenic Area
- Nitrate Sensitive Area
- Nitrate Vulnerable Zone
- Ramsar Site
- Site of Special Scientific Interest
- Special Area of Conservation
- Special Protection Area



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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]

[illegible]

SITE DETAILS Grid Reference 526060 436930

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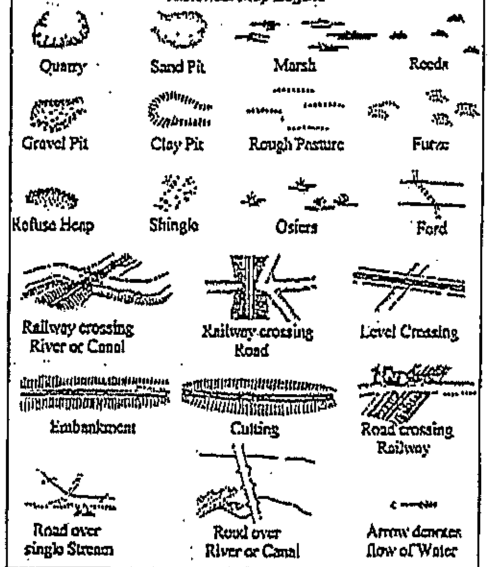
Historical Map Legend



YORKSHIRE

[illegible]

Source map scale [illegible]

1889 | 1891

Date(s) of Publication

Ordnance Survey®

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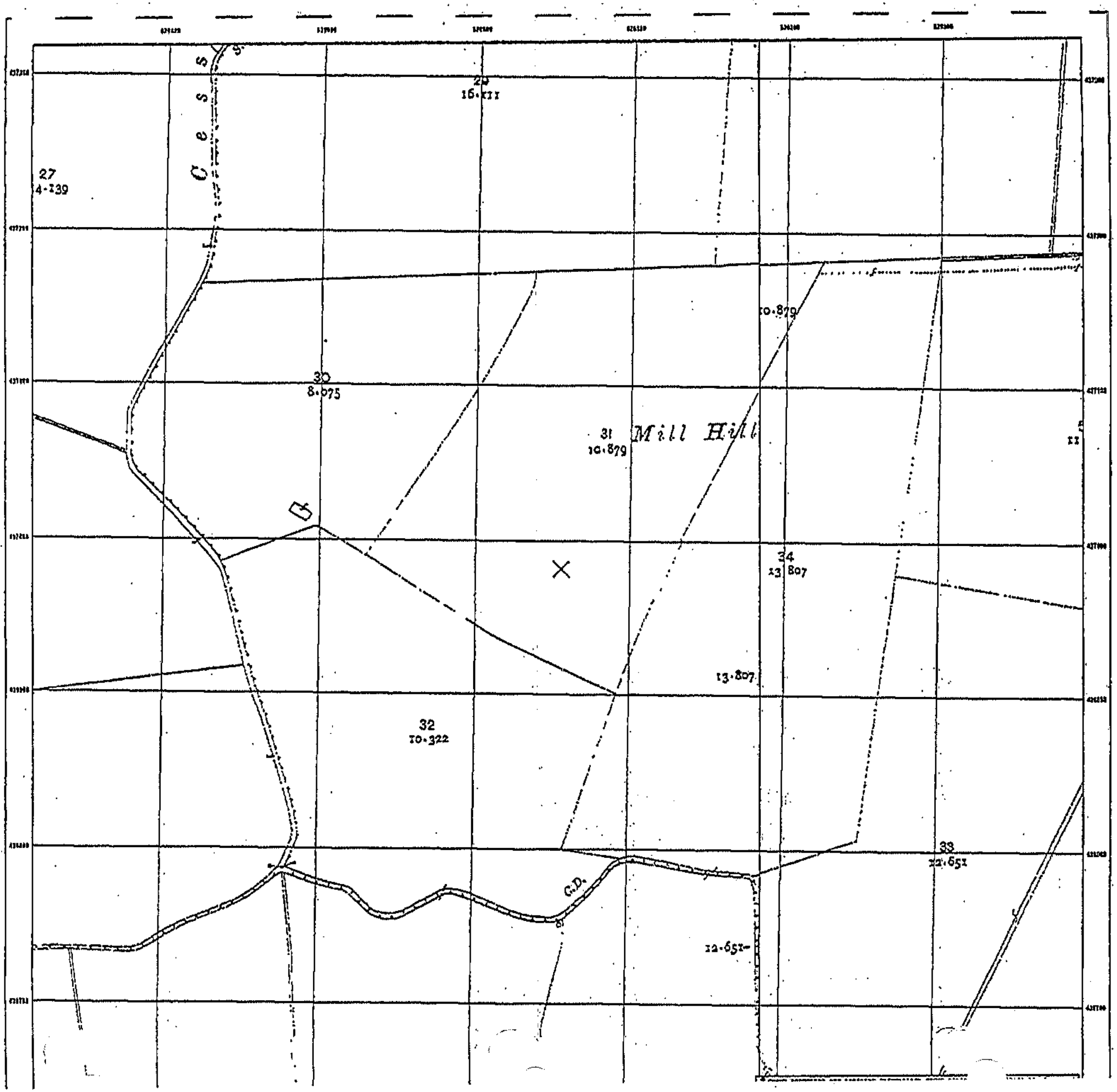

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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]

MOTT MACDONALD

1 Atlantic Quay Robertson Street

GLASGOW

Lanarkshire [illegible]

SITE DETAILS Grid Reference 528060 436980

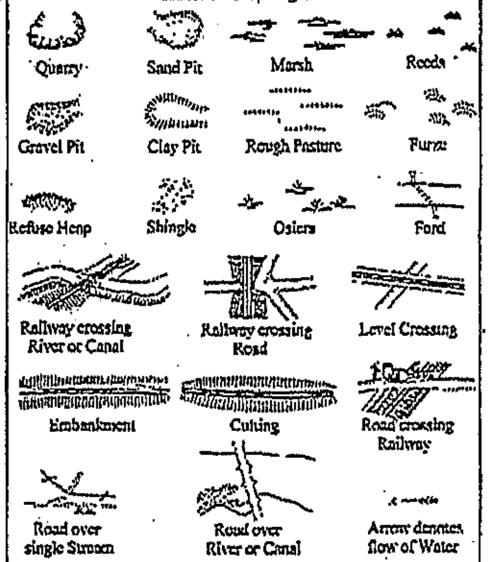
Aldbrough Gas Storage Facility

Aldbrough

East Riding

Yorkshire

Historical Map Legend



YORKSHIRE

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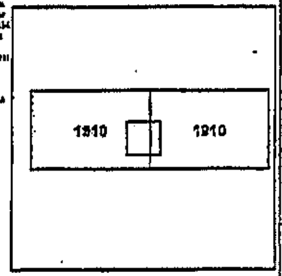

Date(s) of Publication

Ordnance Survey

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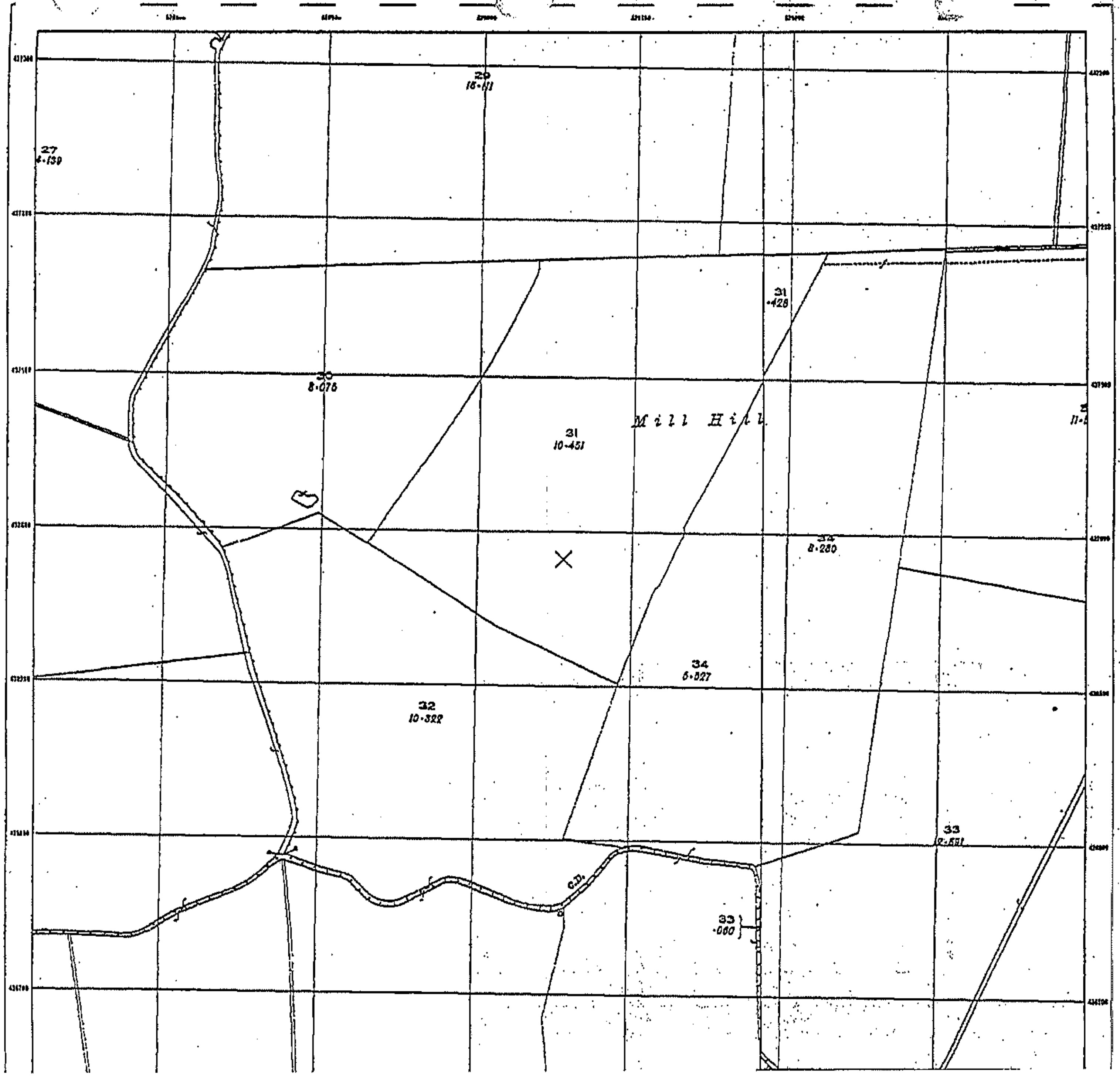

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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

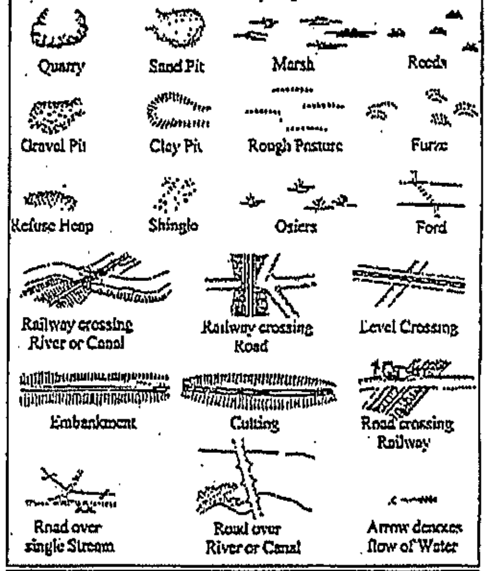
Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

SITE DETAILS Grid Reference 526060 438980

Aldbrough Gas Storage Facility
Aldbrough
East Riding

Yorkshire

Historical Map Legend



YORKSHIRE

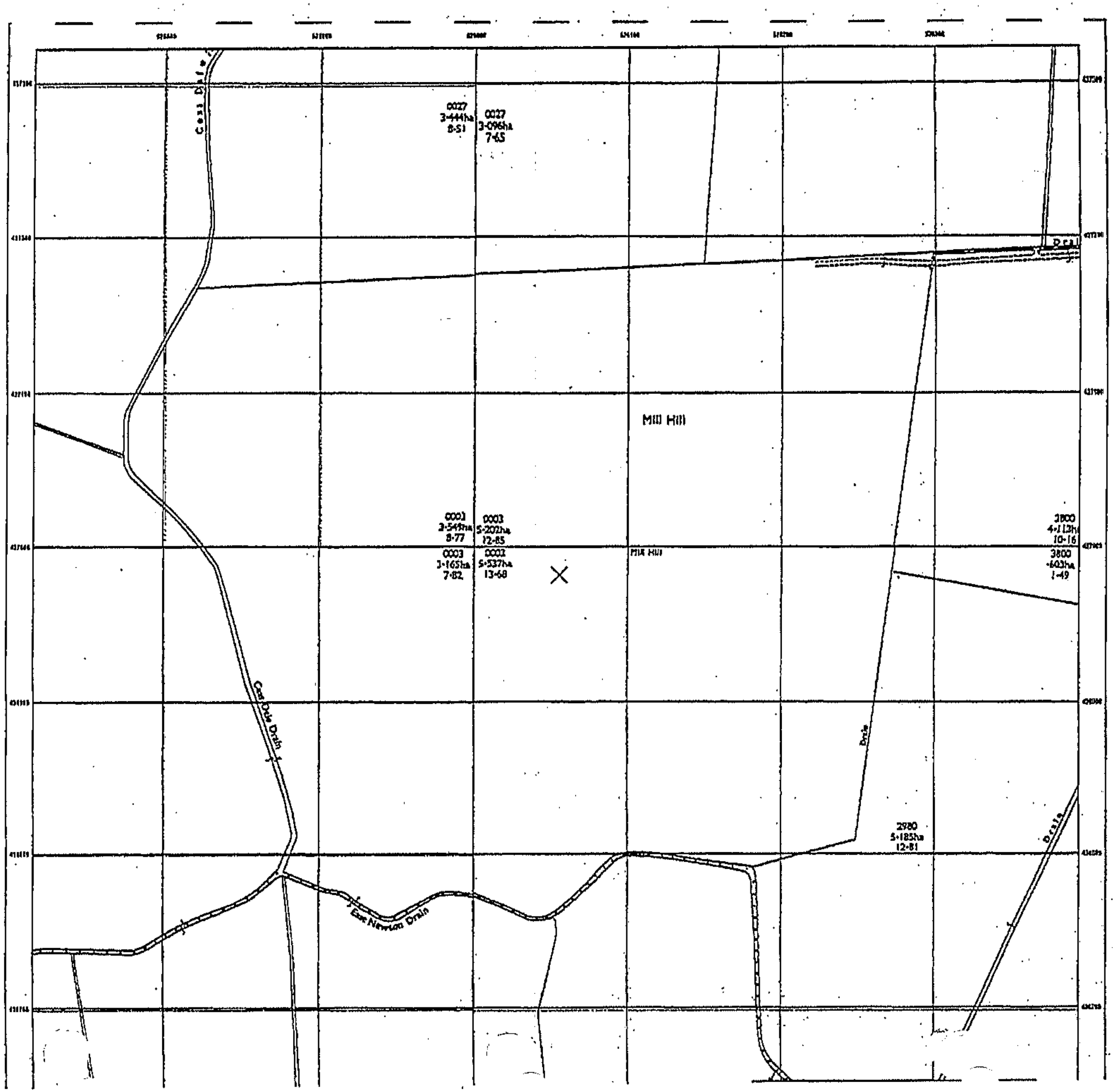
[illegible]

Source map scale: [illegible]

1927	1927

Date(s) of Publication

Ordnance Survey® LANDMARK®



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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 [illegible]

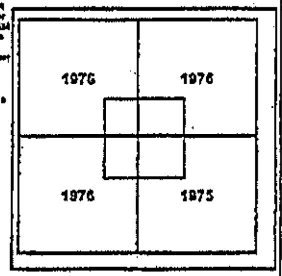
SITE DETAILS Grid Reference 526060 436950

Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire

Historical Map Legend

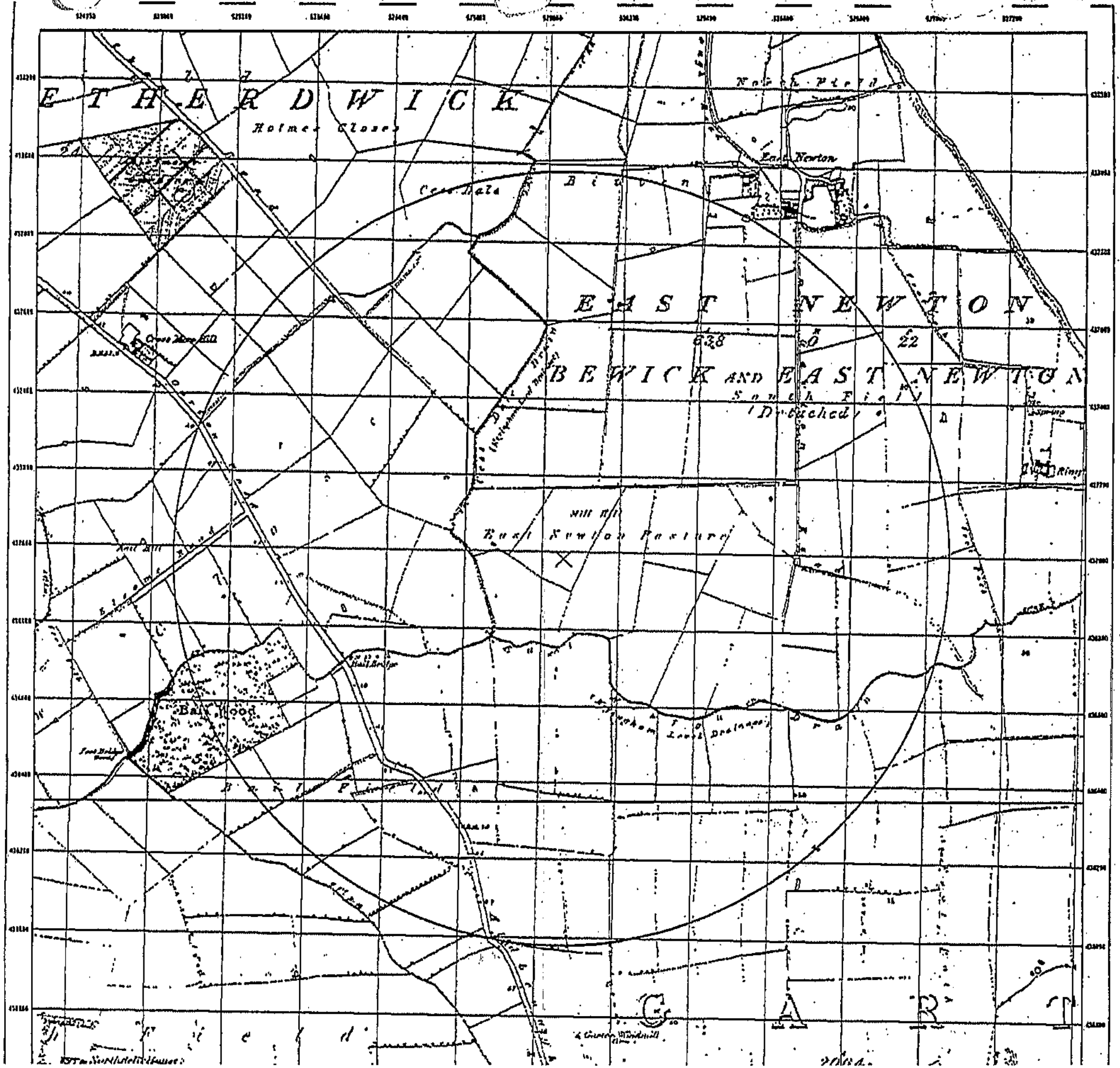
- Inactive Quarry, Chalk Pit or Clay Pit
- Active Quarry, Chalk Pit or Clay Pit
- Culvert
- Slope
- Slope
- Pylon
- Electricity Transmission Line
- Direction of Water flow
- Coppice, Osier
- Marsh
- Saltings
- Orchard Tree
- Reeds
- Rough Grassland
- Scrub
- Heath
- Bracken
- Coniferous Tree (Surveyed)
- Coniferous Tree (Not Surveyed)
- Non-coniferous Tree (Surveyed)
- Non-coniferous Tree (Not Surveyed)

ORDNANCE SURVEY PLAN



Date(s) of Publication

Ordnance Survey® LANDMARK®



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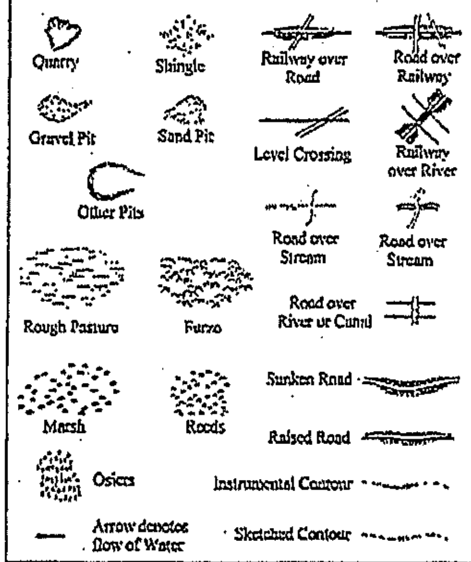
CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
[illegible]
[illegible]
GLASGOW,
[illegible]

SITE DETAILS Grid Reference 525060 436960

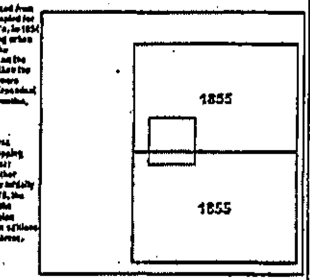
Aldbrough Gas Storage Facility
Aldbrough
East Riding

Yorkshire



YORKSHIRE

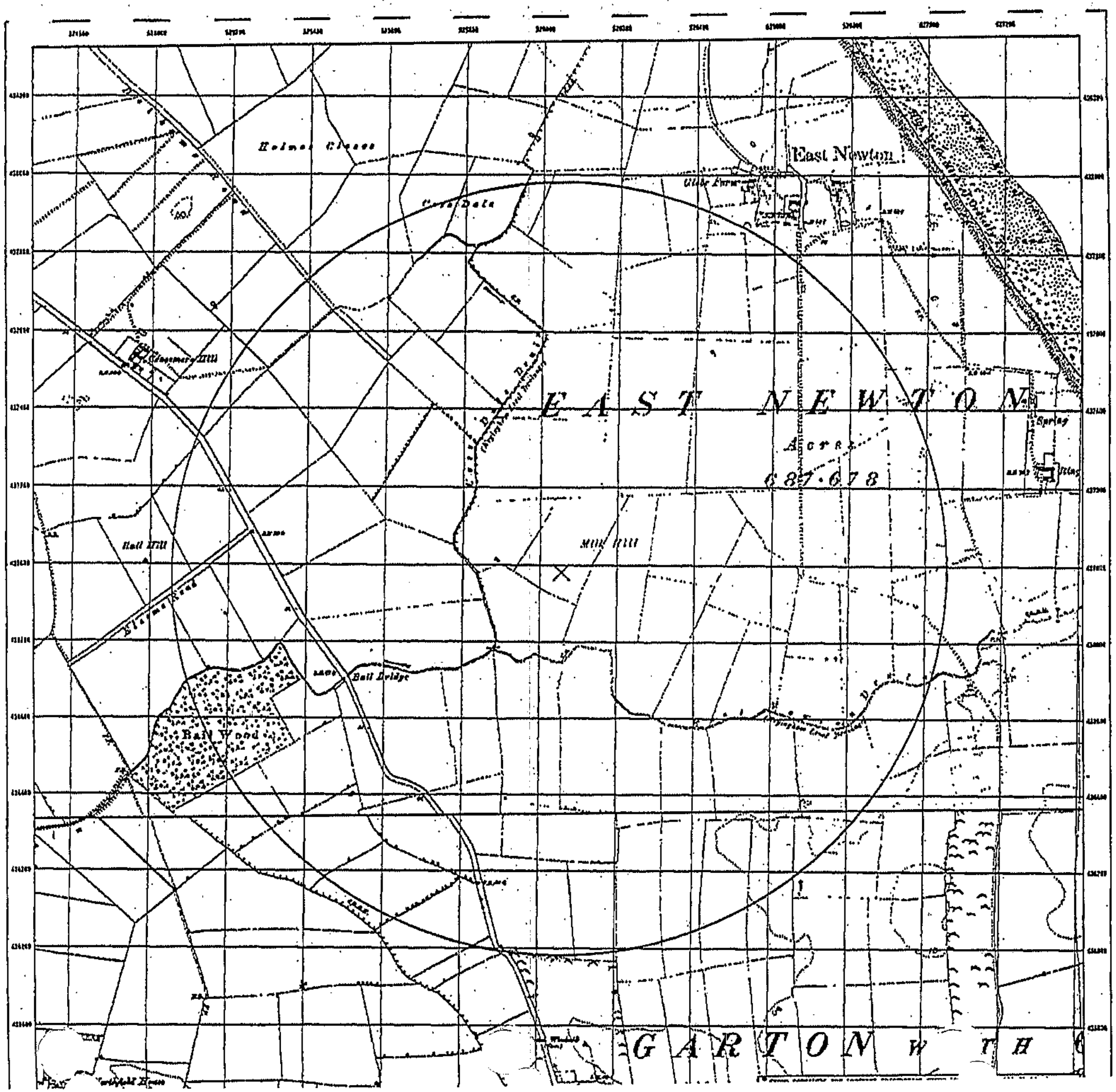
[illegible]



Date(s) of Publication

Ordnance Survey

LANDMARK



Envirocheck®

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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

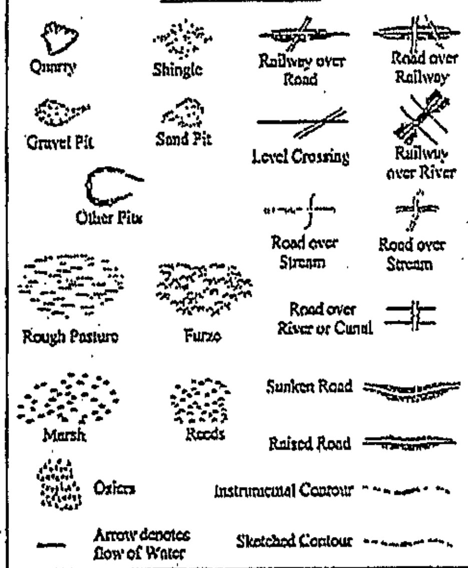
Customer Ref:

MOTT MACDONALD

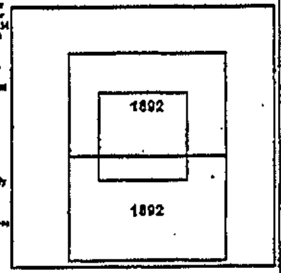
GLASGOW

SITE DETAILS Grid Reference 526060 436980

Yorkshire



YORKSHIRE



Date(s) of Publication

Ordnance Survey®

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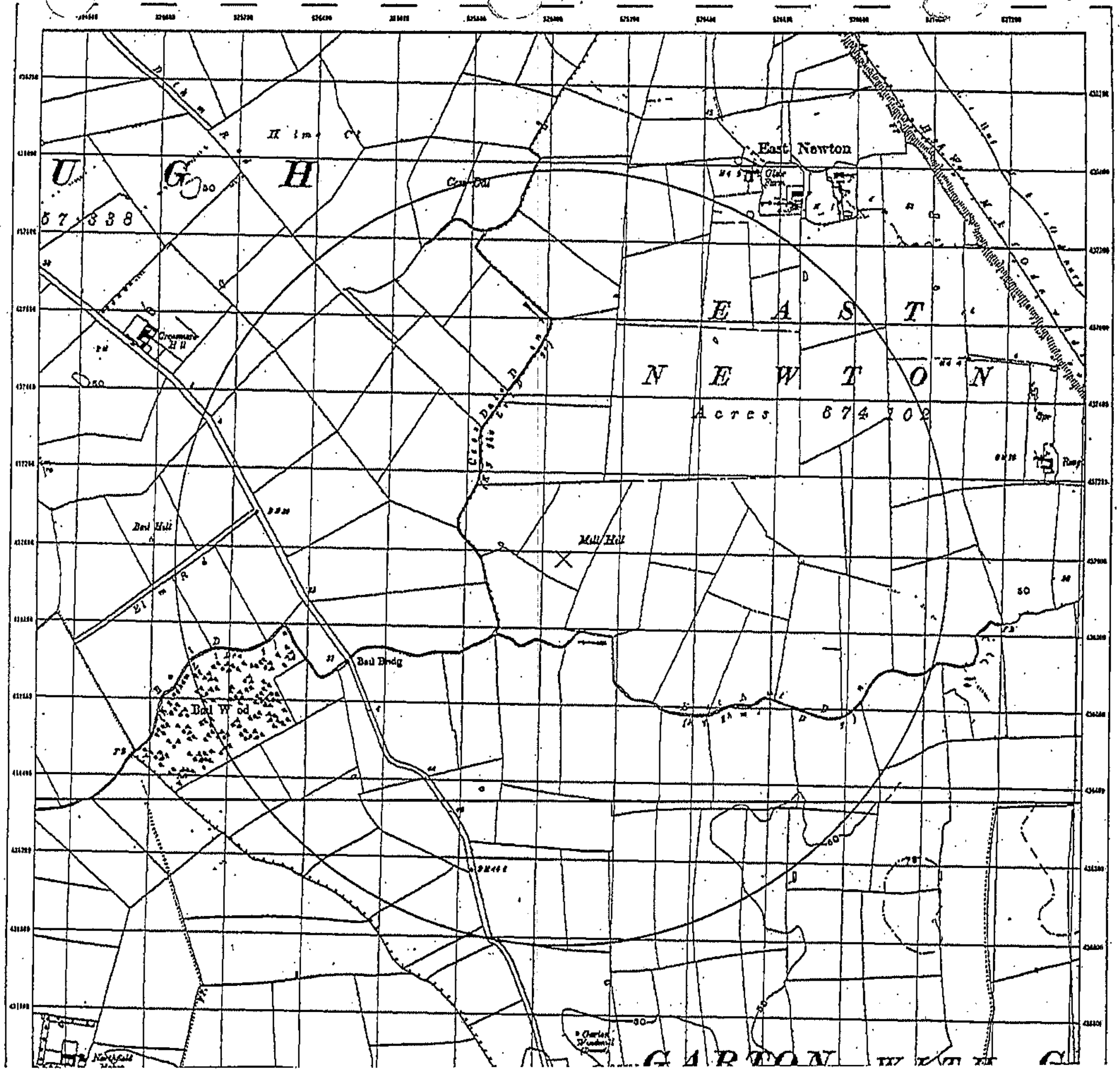

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CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire, G2 8JB

SITE DETAILS Grid Reference 520060 436860

Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire

Historical Map Legend

Quarry · Shingle · Railway over Road · Road over Railway · Gravel Pit · Sand Pit · Level Crossing · Railway over River · Other Pits · Road over Stream · Road over Stream · Rough Pasture · Furze · Road over River or Canal · Marsh · Reeds · Sunken Road · Raised Road · Osiers · Instrumental Contour · Arrow denotes flow of Water · Sketched Contour

YORKSHIRE

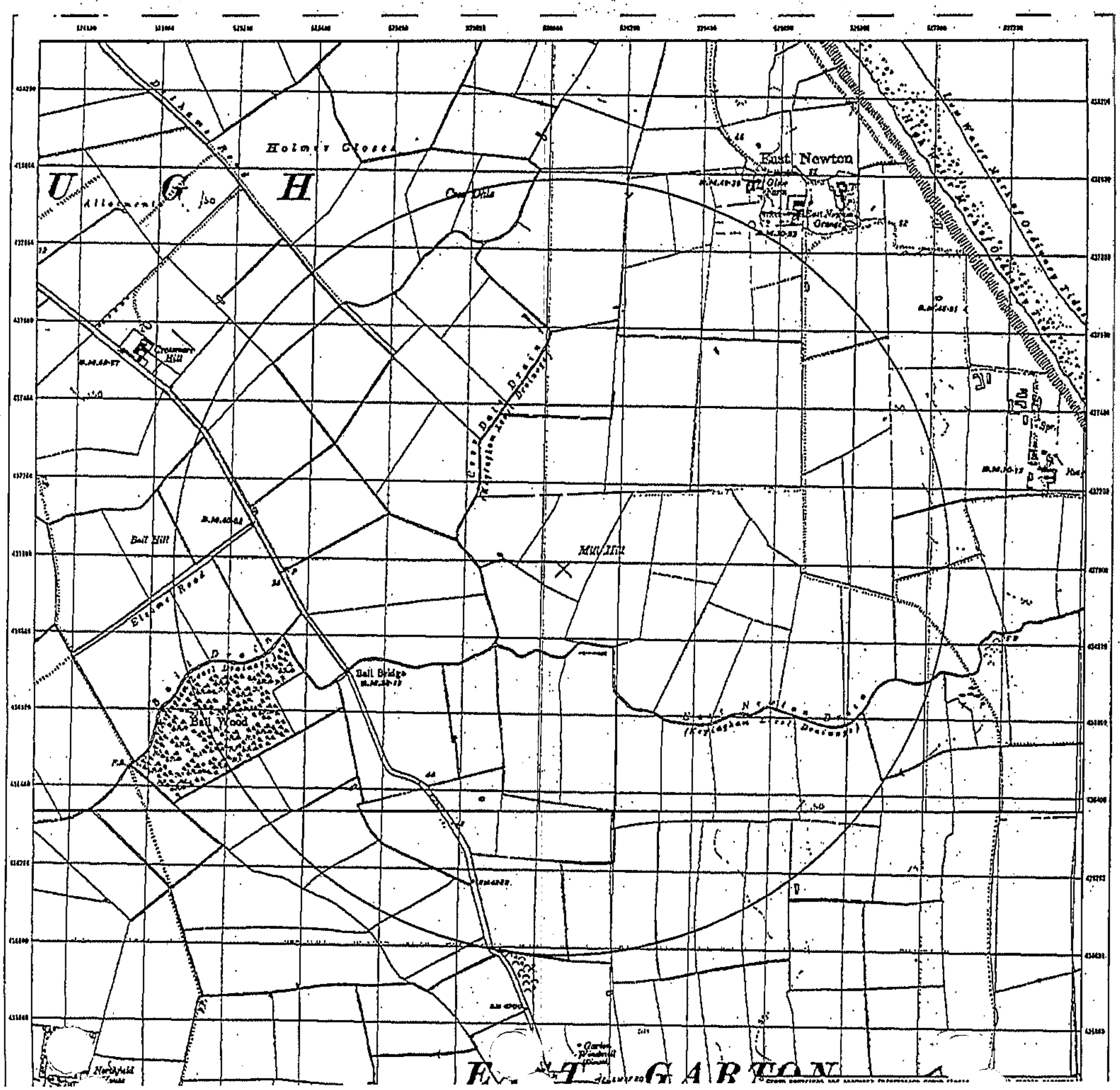
[illegible]

Source map scale: 1:10,560

1910
1910

Date(s) of Publication

Ordnance Survey® LANDMARK®



Envirocheck

A Landmark product

CLIENT DETAILS — Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

SITE DETAILS — Grid Reference 526060 436980

Aldbrough Gas Storage Facility
Aldbrough
East Riding

Yorkshire

Historical Map Legend

- Quarry
- Shingle
- Railway over Road
- Road over Railway
- Gravel Pit
- Sand Pit
- Level Crossing
- Railway over River
- Other Pits
- Road over Stream
- Road over Stream
- Rough Pasture
- Furze
- Road over River or Canal
- Sunken Road
- Marsh
- Reeds
- Raised Road
- Osiers
- Instrumental Contour
- Arrow denotes flow of Water
- Sketched Contour

YORKSHIRE

[illegible]

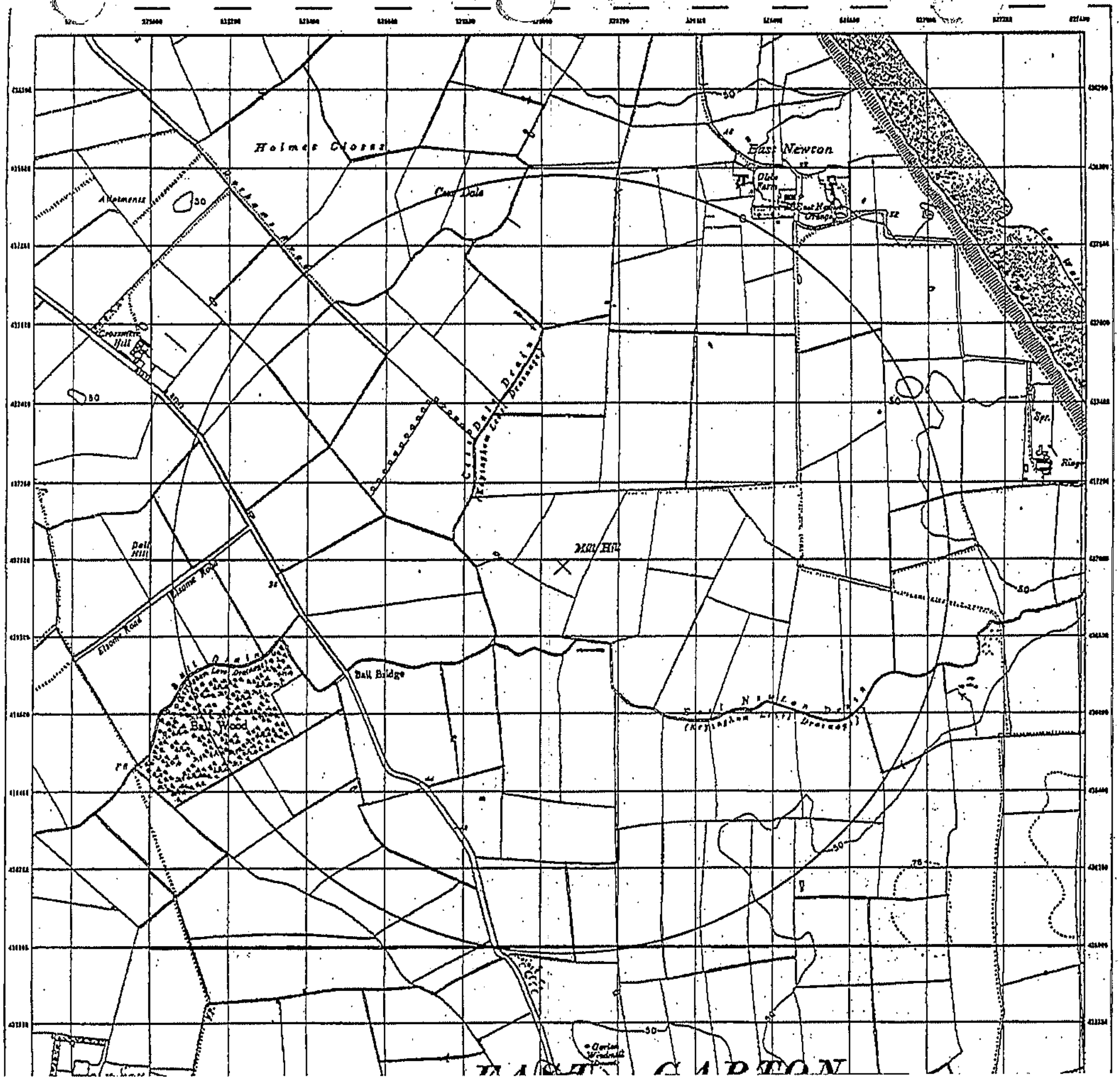
[illegible]

[illegible]

1952

1951

Date(s) of Publication



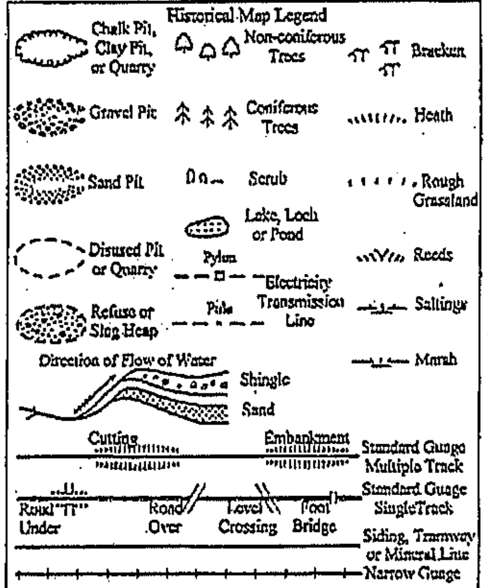
Envirocheck
A Landmark product

CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
[illegible]

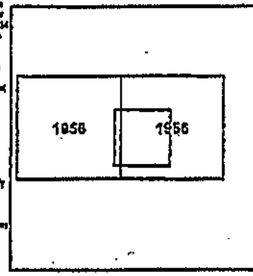
SITE DETAILS Grid Reference 520080 438980

Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire



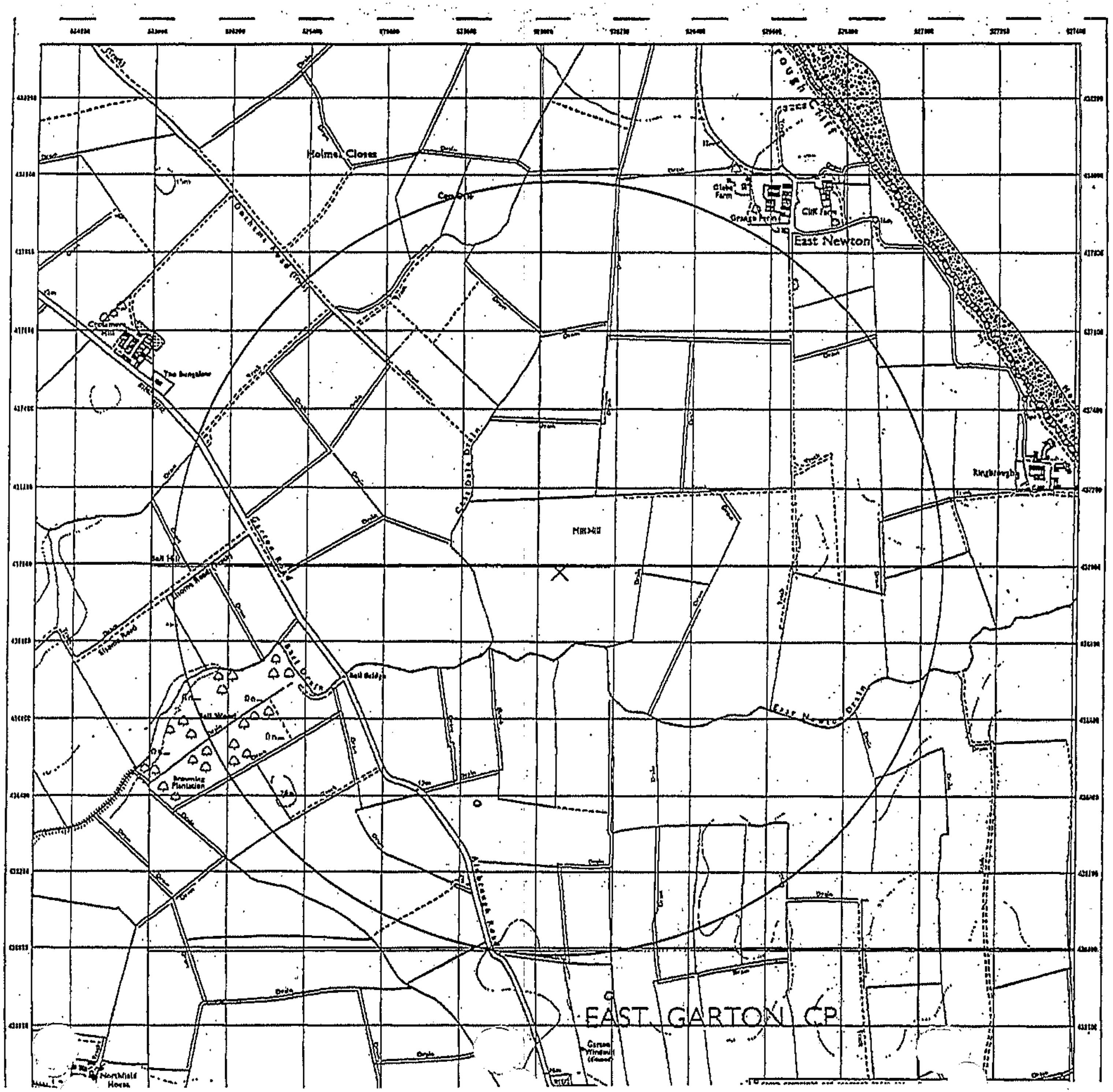
ORDNANCE SURVEY PLAN

[illegible]



Date(s) of Publication

Ordnance Survey
LANDMARK



Envirocheck®

A Landmark® product

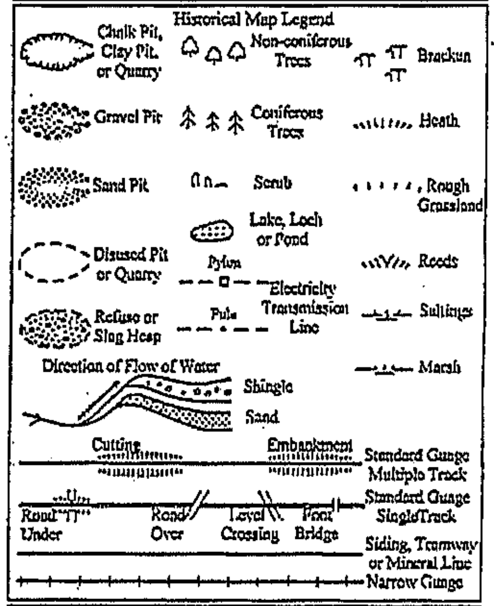
CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: MA S Gamil,HCGSPUMEST
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

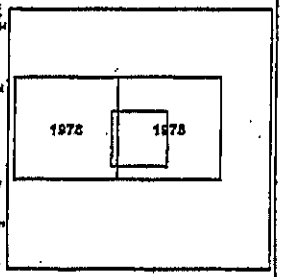
SITE DETAILS Grid Reference 526060 436980

Aldbrough Gas Storage Facility
Aldbrough
East Riding

Yorkshire

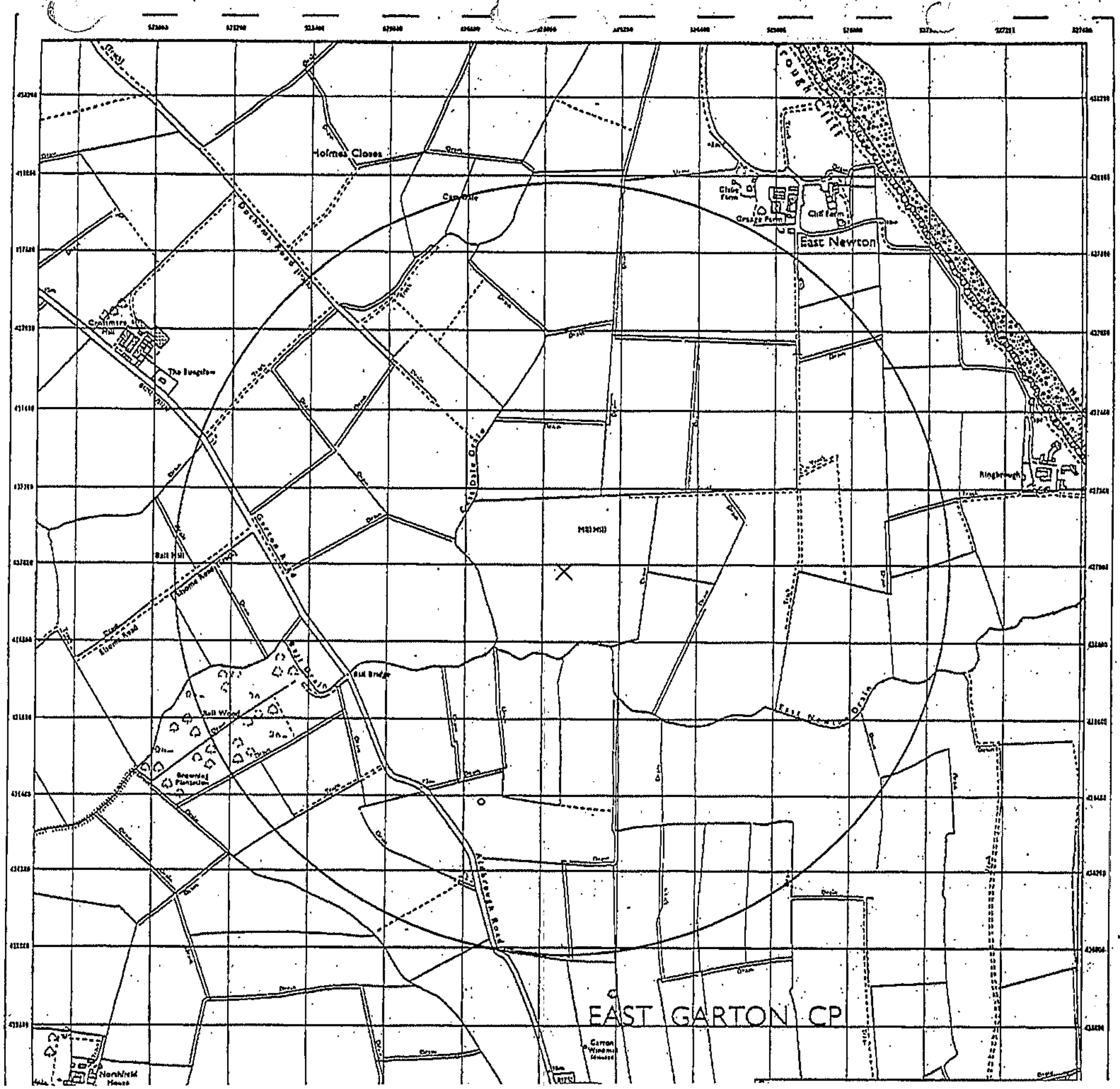


ORDNANCE SURVEY PLAN



Date(s) of Publication

Ordnance Survey® LANDMARK®



Envirocheck®

A Landmark product

CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]

MOTT MACDONALD

1 Atlantic Quay Robertson Street

GLASGOW

Lanarkshire G2 8JB

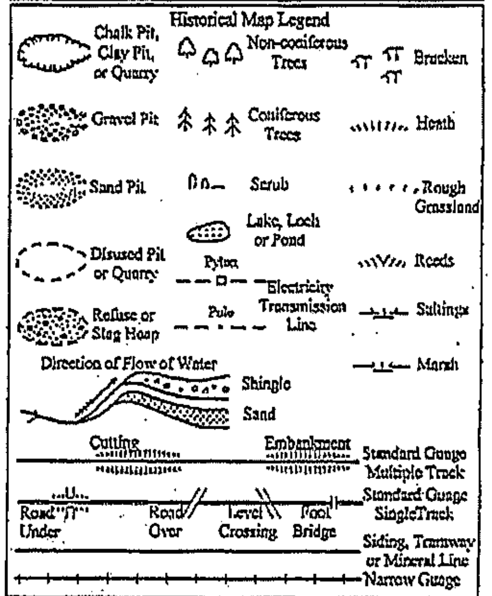
SITE DETAILS Grid Reference 526080 436950

Aldbrough Gas Storage Facility

Aldbrough

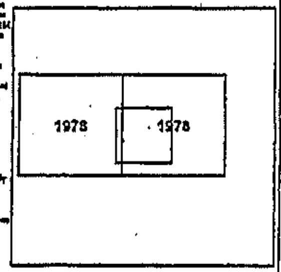
East Riding

Yorkshire



ORDNANCE SURVEY PLAN

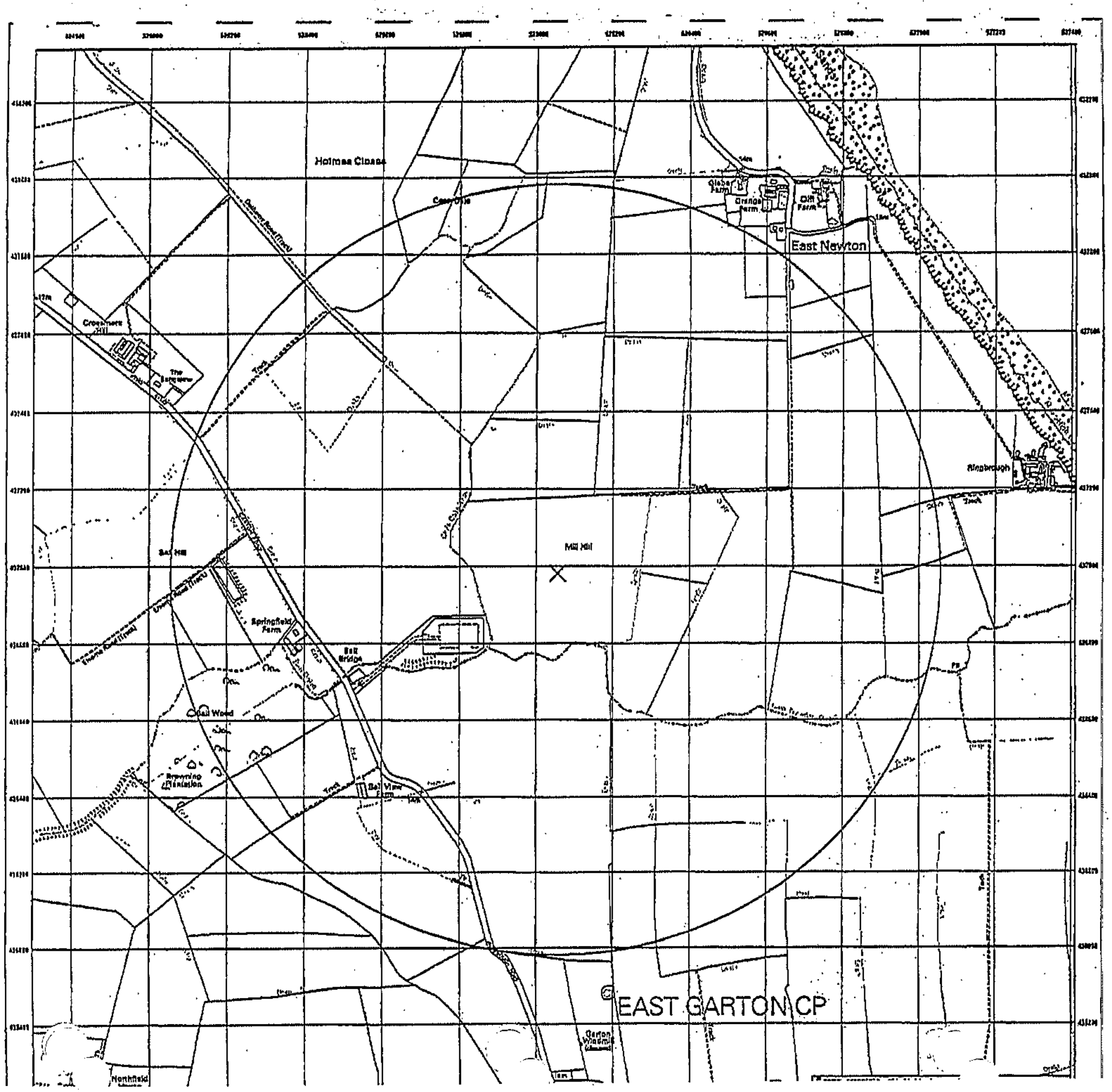
[illegible]



Date(s) of Publication

Ordnance Survey

LANDMARK®



Envirocheck
A Landmark product

CLIENT DETAILS Envirocheck Order No. EC300103_1_1

Customer Ref: [illegible]
MOTT MACDONALD
1 Atlantic Quay Robertson Street
GLASGOW
Lanarkshire G2 8JB

SITE DETAILS Grid Reference 526060 436980

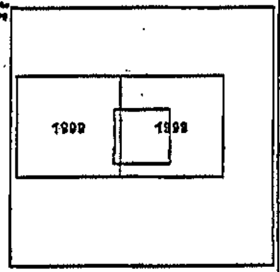
Aldbrough Gas Storage Facility
Aldbrough
East Riding
Yorkshire

Historical Map Legend

Non-coniferous Trees	Pylon
Coniferous Trees	Telephone Line (where shown)
Orchard	Electricity Transmission Line (with poles)
Rough Grassland	Gravel Pit
Heath	Shingle
Scrub	Refuse Tip or Slag Heap
Marsh, Salt Marsh or Reeds	Sand
County Boundary (England only)	Sand Pit
Civil Parish or Community Boundary	Slopes
Constituency Boundary	District, Unitary, Metropolitan, London Borough Boundary

ORDNANCE SURVEY PLAN

[illegible]



Date(s) of Publication

Ordnance Survey
LANDMARK

APPENDIX C

GeoReports

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Geological Assessment - Standard

Report prepared for:

Nicola Best
MOTT MACDONALD
111 St Marys Road
Sheffield
South Yorkshire
S2 4AP

Geological Assessment - Standard

This report is aimed at users carrying out preliminary site assessments, who require a brief indication of the geology and related geological subsidence hazards around the site.

The report, prepared by BGS geologists, is based on analysis of records and maps held in the National Geoscience Data Centre (NGDC), and includes descriptions of rock types, natural subsidence hazards and mining & quarrying hazard if present. It also contains a listing of the key geoscience data sets held in the NGDC for the area around the site.

The report does not, however, consider radon hazard or detailed hydrogeology at the site (these are described in the Detailed Geological Assessment report, available separately).

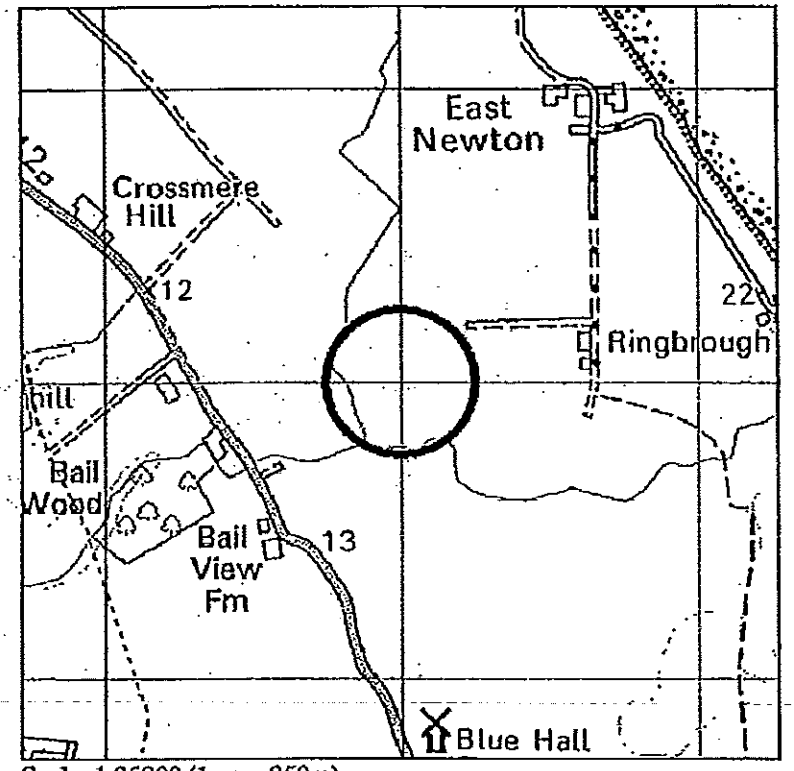
Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

Client's Reference:
HCGOPUME01

Section 1: Location and extent of report area

Area centred at: 526000,0437000
Radius of site area: 250 metres

This report is based on the above location details. However, where the client has submitted a site plan, it is used for the assessment in Sections 2 and 3.



Scale: 1:25000 (1cm = 250m)

SITE LOCATION

Section 2: Geological Considerations within the Search Area

This table lists the principal geological considerations that may affect a site, and is based on interpretation of data available to BGS at the time of compilation; additional information may be available in BGS files. The information is designed to act as a checklist and should not be used in place of a detailed site investigation.

Geohazard type	Should be considered at this site	Comments
Swell-shrink clay		
Shallow mining		
Unstable ground		
Dissolution features		
Compressible ground	✔	High susceptibility
Running sand	✔	Moderate susceptibility
Artificial ground	✔	Moderate susceptibility
Natural land gas		
Shallow Groundwater	✔	Small quantities of water may be encountered in any Made Ground where present and in the coarser grained horizons within the Alluvium. This water will probably be in hydraulic continuity with local surface water courses. Water is also likely to be encountered in any sand and gravel horizons present within the Till deposits. The rest water level in the Chalk is likely to rise above where struck to between 10 and 15 metres below ground level.
Aquifer vulnerability	✔	The Chalk is classified as a Major Aquifer, however in this area it is overlain by more than 5 metres of low permeability superficial deposits and considered protected. Therefore the Superficial Deposits have been classified instead. The Alluvium is classified as a Minor Aquifer and has a high soil leaching potential. The Till is classified as a Non Aquifer, however some groundwater flow through these rocks may occur and should be considered when assessing the risk associated with persistent pollutants.

Section 3: Description of the Geology within the Search Area

Artificial Ground:

Recent and historic topographic maps show that the proposed site is partially covered by development (specifically to the south-west boundary). It is therefore likely that limited artificial deposits (probably landscaped or made ground) will be encountered. Specific information concerning the thickness or nature of any artificial deposits is not available.

Superficial Deposits:

Geological mapping at 1:10560 scale shows that the proposed site is underlain by a substrate of till, with an overlying body of alluvium to the south and west.

The alluvium rests on the till, and may be characterised by soft to firm consolidated, compressible silty clay, possibly including layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present. The alluvium is associated with recent sedimentation from local watercourses. The alluvium is estimated to have a thickness of greater than 1 m, however no specific information is available concerning the exact thickness or composition of this deposit.

The till represents a group of sediments laid down by the direct action of glacial ice. Till deposits are characterised by a variable lithology, usually sandy, silty clay with pebbles, cobbles and boulders. Gravel-rich, and laminated sand layers are known to exist within the till deposit, and may be prone to "running sand".

Rockhead Depth:

The depth to rockhead (bedrock) is not known with any degree of certainty, but it is estimated to be around 41 metres (based on an existing borehole located approximately 1km to the east of the proposed site (Ref. TA23NE/4).

Solid Geology:

Geological mapping shows the proposed site to be underlain by the Rowe Chalk Formation, of Cretaceous age. The Rowe Chalk Formation is characterised by white, flint-bearing chalk with sporadic marl bands. This rock unit is estimated to reach a thickness of approximately 50 m in the area of the proposed site, underlain by the Flamborough Chalk Formation. The Rowe Chalk Formation is interpreted to dip gently to the northeast by approximately 2 degrees.

Hydrogeological Information
The generalised Groundwater Vulnerability around the site is described in Section 2.

A more detailed hydrogeological assessment can be obtained as part of the Geological Assessment Detailed report which costs £275 (incl. VAT and delivery). The detailed hydrogeological assessment describes aquifer characteristics, groundwater levels, water table fluctuations, groundwater quality and groundwater vulnerability in the context of the geological assessment.

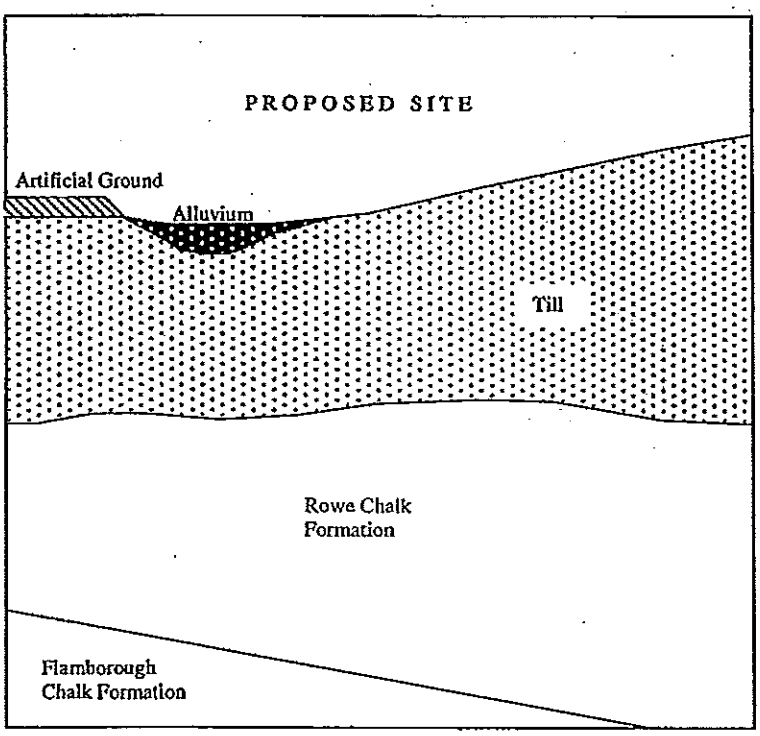
Radon
Two separate reports, for £35.25 (incl. VAT and delivery) and £140 (incl. VAT & delivery) are available describing the level of Radon Protective Measures required during the construction of new dwellings, or extensions to existing properties, at the site. The first is a lower resolution (1:250,000 or 1:50,000 scale) search generated automatically using the BGS Radon Protective Measures GIS, while the second is a higher resolution ((1:50,000 or 1:10,000 scale) search carried out manually by BGS geologists for the site area. Both reports fulfil the Stage 2 requirements for a geological assessment outlined in BRE publication (BR211, 1999): *Radon: Guidance on protective measures for new dwellings.*

Section 4: Schematic Geological Cross-Section of the Site

Not to scale

grid ref of SW side of site [525800,436830]

grid ref of NE side of site [526180,437200]

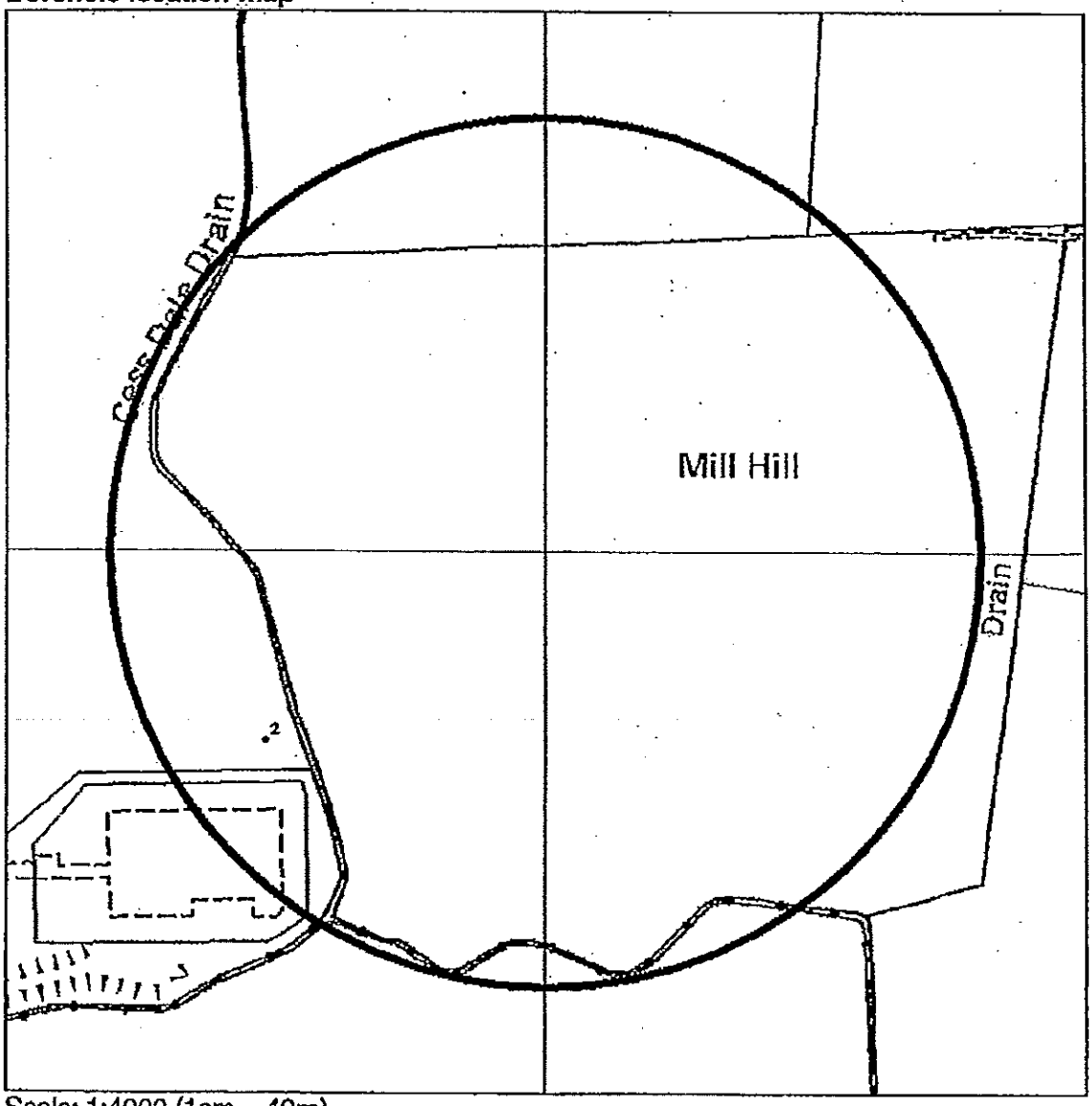


This sketch represents an interpretation of the geometrical relationships of the main rock units described in the text. Not to scale.

Section 5: List of geological data available in search area

This section lists the principal data sets held in the National Geoscience Records Centre that are relevant to the search area. Descriptions of the data sets and how to obtain copies of records from them are given in Section 5. Users with access to computing facilities can make their own index searches using the BGS Internet Geoscience Data Index, accessible through the BGS website at www.bgs.ac.uk

Borehole location map



Scale: 1:4000 (1cm = 40m)

Borehole records
(A blank Length field indicates the borehole is confidential or no depth has been recorded digitally.)
Total number of records: 1

The 'Office' column shows the office at which the records are held and from where copies can be obtained (see contact details later in the report). KW=Keyworth, MH & MW=Murchison House,

WL=Wallingford, EX=Exeter

Regno	Grid_reference	Name	Length	Office	SIR
TA23NE2/B	TA 25840 36890	HOLDNESS NORTH (SRS) (BP 66) 2071	18.28	KW	

There are no records for Water Well Records in the selected area

There are no records for Boreholes with water level readings in the selected area

There are no records for Locations with aquifer properties in the selected area

There are no records for Site investigation reports, England and Wales in the selected area

There are no records for National Grid geological maps (1:10,000 and 1:10,560 scale) in the selected area

County Series geological maps (1:10,560 scale)
Total number of records: 3

Map	Type	Published
Yorkshire213FS	D	
Yorkshire213SW	C	
Yorkshire213SW		1881

New Series medium scale geological maps (1:50,000 and 1:63360 scale)
Total number of records: 3

Sheet	Title	Type	Survey	Published	Revision
73	Hornsea	C	1881	1998	
73	Hornsea	D		1883	
73	Hornsea	D		1883	

Old Series one inch geological maps (1:63360 scale)
Total number of records: 1

Sheet	Title	Type	Survey	Published	Revision
94SE	Hornsea	D		1883	

There are no records for Geological Memoirs in the selected area

There are no records for Technical reports in the selected area

There are no records for Waste sites in the selected area

There are no records for Mining plans in the selected area

Section 6: Descriptions of BGS databases

Note that this report is not a definitive listing of all data held in BGS.

Borehole Records and Water Wells

Records of boreholes, shafts and wells from all forms of drilling and site investigation work. Some 900,000 records dating back over 200 years and ranging from one to several thousand metres deep. Currently some 50,000 new records are being added to the collection each year.

A small percentage of the borehole records are held commercial-in-confidence for various reasons and cannot be released without the written permission of the originator. If any of the records you need are listed as confidential apply in the normal way. BGS Enquiry Service staff will release the data where this is possible or provide you with the information needed to contact the originator.

Where records are held in more than one office, the contents may differ. Enquiries principally requiring water related information should contact the Wallingford or Edinburgh office.

Water levels

These represent a subset of records within the National Well Record Archive of water wells and boreholes where there are either digital or analogue time series of water levels, or where available water level data span multiple years. Time series data are held for approximately 1500 boreholes distributed nationally. Other water level data is available where records have been inspected and digitised. Records are identified by the Well Registration number used for water wells (see above). Please contact our Wallingford office to discuss your specific requirements and to obtain costs.

Aquifer properties

These are locations where data on aquifer physical properties (transmissivity, specific yield, storage, porosity or hydraulic conductivity) are held. The data include raw data from field and laboratory investigations, and site-specific summaries of the data. Coverage is limited to aquifers in England and Wales. Records are identified by an aquifer property identifier, which should be quoted when ordering data. This data should be ordered separately, but will normally be provided and charged for as part of the relevant borehole records.

Site investigation reports

Additional laboratory and test data may be available in these reports, subject to any copyright and confidentiality conditions. The grid references used are based on an un-refined rectangle and therefore may not be applicable to a specific site. Borehole records in these reports will be individually referenced within the borehole records collection, described above.

Geological maps

- **National Grid maps (1:10,000 and 1:10560 scale)** - Since the 1960s the standard large scale map for recording geological information has been the Ordnance Survey (OS) quarter sheet covering a 5km square area. The maps are supplied in different formats depending on their age and the method of reproduction used. Only the latest most up-to-date version is listed.

- **County Series map sheets (1:10,560 scale)** - Maps produced on OS County Series sheets between approximately 1860 and 1960. The list indicates distinct examples of maps from separate surveys or revisions. It is advisable to discuss your requirements before ordering or travelling to view these maps.

- **New Series medium scale maps (1:50,000 and 1:63360 scale)** - Maps at either scale covering the OS New Series one inch map sheet areas used by BGS. Please note that the sheet numbering is not the same as used for current OS 1:50,000 topographic maps.

- **Old Series medium scale one inch maps (1:63,360 scale)** - Early geological mapping covering the OS Old Series one inch map sheet areas. Applies to England and Wales only.

While there may be information relevant to your enquiry on older maps, you will generally want the latest edition, and National Grid maps will be preferred to County Series maps, and New Series to Old Series.

Memoirs

Explanatory sheet memoirs describing the geology of the areas covered by either the medium scale (1:50,000 and 1:63,360) map series.

Technical reports

The open file reports listed are mainly from the Onshore Geology Series. These include descriptions of the geology for the National Grid series geological sheets. Please note that the location details in the database are not yet complete so it is possible that not all the relevant reports available will be listed.

Waste sites

Listing of some 3500 waste sites for England and Wales identified by BGS as part of a survey carried out on behalf of the Department of the Environment in 1973. Later information is available from the Environment Agency.

Mine Plans

Plans of various types, principally relating to mining activity and including abandonment plans. For mine plans, the coverage is not comprehensive, but that for Scotland is the most complete. The search includes the collection of Plans of Abandoned Mines (Other than Coal & Oil Shale) for Scotland and the non-coal plans in the BGS Land Survey Plans collection, (mainly Scotland). Microfilm copies of the Plans of Abandoned Mines (Coal & Oil Shale) for Scotland and the Coal Authority's catalogues are available for consultation by prior appointment.

The mine plans listed for the rest of England and Wales (excluding SW England, which is not covered) include working copies, compilations and interpretations which may be copyright or confidential and therefore not be available for purchase. The general nature of some of the plans means that they may not be applicable to a specific site. However, the presence of mining data could indicate that further specialist advice or interpretation is required. Large scale plans produced for site investigations or other purposes are also included for completeness.

Section 7: How to access or inspect data

Borehole Records – *contact BGS Enquiry Service (see end of section)*

Copies of borehole records can be supplied (order form enclosed) at the flat rate of £13 (+VAT) per log with a minimum charge £26 (+VAT). Normal first class postage within the UK is included. Next day recorded delivery or express parcel dispatch is available on request and charged at cost. Copies of documents can be forwarded by facsimile transmission at an additional charge of £0.50 (+VAT) per A4 sheet. Records with additional detailed geological information derived from BGS examination of borehole material may be charged at the current 'value-added' rate. If you have a need for data with particular geological characteristics, the please contact the enquiries office to discuss your requirements (additional charges may apply).

Alternatively you can make an appointment to visit the relevant enquiry office and examine the records yourself. The Commercial User Ticket (see below) covers inspection of the borehole logs and includes access to a set of relevant documents for one unit area (typically a 5 km x 5 km area). A further charge of £19 (+ VAT) is due for each additional set examined. Data can be freely extracted from the records but any copies requested will be charged as above.

Water wells – *contact BGS Enquiry Service*

Copies of records can be supplied (order form enclosed) at the flat rate of £13 (+VAT) per log with a minimum charge £26 (+VAT). Normal first class postage within the UK is included. Next day recorded delivery or express parcel dispatch is available on request and charged at cost. Copies of documents can be forwarded by facsimile transmission at an additional charge of £0.50 (+VAT) per A4 sheet. If you

have a need for data with particular hydrogeological characteristics, then please contact the relevant enquiries office (England and Wales =Wallingford, Scotland=Edinburgh) to discuss your requirements (additional charges may apply).

Alternatively you can make an appointment to visit the relevant enquiry office and examine the records yourself.

Records for England and Wales are held at Wallingford where the visitor charge is £9.50/hour (+VAT, with a minimum charge of £19 (+VAT).

Records for Scotland are held with the borehole records at our Edinburgh office the above Borehole Record charges cover them and apply.

BGS Memoirs, maps and open file reports – *contact BGS Sales (details below)*

BGS Memoirs, maps and open file reports relevant to your area can be examined in the appropriate BGS Library. Copies can be ordered from our main Sales Desk: Sales Desk, British Geological Survey, Keyworth, Nottingham NG12 5GG Tel: 0115 936 3241, Fax: 0115 936 3488, E-mail: sales@bgs.ac.uk.

Sales Desks are also located in Edinburgh; Tel: 0131 650 0358, Fax: 0131 667 2785, E-mail: scotsales@bgs.ac.uk, and London; Tel: 020 7589 4090, Fax: 020 7584 8270, E-mail: bgslondon@bgs.ac.uk. BGS London also maintain a reference collection of all BGS publications.

Please check price and P&P before ordering.

Waste Sites – *contact BGS Enquiry Service*

Copies of register entries, containing a variety of levels of data recording, can be obtained from the BGS Enquiry Service (price on application). The registers can also be inspected by visit (see above)

Mine Plans – *contact BGS Enquiry Service*

Mine Plans are available for consultation by prior appointment. Copies can also be obtained - price on application.

Commercial User Ticket – *contact BGS Enquiry Service*

A combined day ticket for commercial visitors to the National Geological Data Centre and the Library is £55 (+VAT) and there is a £33 (+VAT) day ticket for visitors who only wish to use the Library. Frequent visitors can purchase an annual subscription at £275 (+VAT) for access to the NGDC and the Library or £155 (+VAT) for use of the Library only. Further details can be provided on request.

BGS ENQUIRY SERVICE Contact Details:

Keyworth (KW) Office
For Borehole and other records (excluding water well records & hydrogeological data) in England & Wales (excluding Northern England, and Devon & Cornwall):
Records & Data Enquiries
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363109
Fax: 01159 363276

Exeter (EX) Office
For Borehole and other records (excluding water well records & hydrogeological data) in Devon & Cornwall:
Records & Data Enquiries
BGS Exeter Business Centre
Forde House
Park Five Business Centre
Harrier Way
Sowton
Exeter
Devon EX2 7HU
Tel: 01392 445271
Fax: 01392 445371

Wallingford (WL) Office
For water well records and hydrogeological data (water levels, water chemistry and aquifer properties) in England & Wales:
Records & Data Enquiries
British Geological Survey,
Maclean Building,
Wallingford,
Oxford OX10 8BB.
United Kingdom
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Murchison House (MH or MW) Office:
For water well records and hydrogeological data for Scotland, and all other records in Scotland & Northern England:
Records & Data Enquiries
Murchison House
West Mains Road
Edinburg
EH9 3LA
Tel: 0131 650 0282
Fax: 0131 667 2785
Email: boreholesnorth@bgs.ac.uk

Section 8: More detailed geological reports available from BGS

This report forms part of a range of reports offered by the BGS Enquiry Service, including reports describing site geology, hydrogeology and geological hazards. For details on these please contact:

BGS Central Enquiries Desk
British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham NG12 5GG
Tel: 0115 936 3143
Fax: 0115 936 3143
Email: enquiries@bgs.ac.uk

Or visit the Enquiry Service pages on the BGS website at www.bgs.ac.uk

Section 9: Terms and Conditions

General Terms & Conditions

This report is supplied in accordance with the GeoReports Terms & Conditions available on the BGS website at www.bgs.ac.uk/georeports and also available from the BGS Central Enquiries Desk at the above address.

Important notes about this report

- The data, information and related records supplied in this report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- Detail which is clearly defined and accurately depicted on large-scale maps may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records which have been donated to BGS have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.

Report issued by:

BGS Enquiry Service

APPENDIX D

British Gas

Memorandum

From To

From Roger Collins, To A.Samy,

cc G.Carle, M.Titmus
K.Cross, G.Tabor
M.Mitchell
W.Thomson / H.Currie.

Gas Industry Telephone Number ex.25321 Date 27th.August.92

Subject Reference A.Lake.
P.Baird (Q.S.)

EAST YORKSHIRE SALT CAVITY -
PROVISIONAL SOILS INVESTIGATION

Attached is a copy of Messrs FES's factual report and letter of the 24th.August.92.

The report has been reviewed and is adequate for the civil design for the trial drill works. I shall confirm to FES that further testing and storage of samples is not necessary.

To summarize the report and its inferences please note: area of civil w

1. The soils are suitable for structural fill, TP1-to-5, and winter working is practical provided that excessive rain is not experienced during the contract period. However the real possibility of extensive inclement weather and the tight programme means the contract should allow for provisional quantities of imported granular fill and export(?) of surplus materials. This is an insurance policy to meet the programme.

2. The suitable materials vary substantially from gravels to fine moderately sensitive clays. Samples for a 4.5kg hammer compaction test gave optimum dry densities of 2.085 and 1.800 Mg/m.cube respectively. Taking into account item.1 and these variations close and experienced site supervision will be required.

3. FES have sent us one copy of report but it would be part of the contract documentation. Will you have the report copied or do you require further copies from FES, if so how many? Yes. ✓

4. Trail pit number 6, TP6, indicates a potential problem for constructing any permanent works just North of the East Newton Drain - see also item.5.3 of report; this may be an isolated old excavation, however before considering the overall layout of the plant during the proposed conceptual study a full soils investigation contract should be let with instructions to investigation this area first. This area would of course be suitable for site establishment.

Roger Collins

rvc/east-13

BRITISH GAS PLC

EAST YORKSHIRE SALT CAVITY

PROVISIONAL SOILS INVESTIGATION

ALDBROUGH, EAST YORKSHIRE

FACTUAL REPORT ON SITE INVESTIGATION

Carried out by

FOUNDATION & EXPLORATION SERVICES LIMITED

CONTRACT NO: 2172

AUGUST 1992

BRITISH GAS PLC

EAST YORKSHIRE SALT CAVITY

PROVISIONAL SOILS INVESTIGATION

ALDBROUGH, EAST YORKSHIRE

FACTUAL REPORT ON SITE INVESTIGATION

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CONTRACT NO: 2172

AUGUST 1992

BRITISH GAS PLC

EAST YORKSHIRE SALT CAVITY

PROVISIONAL SOILS INVESTIGATION

ALDBROUGH, EAST YORKSHIRE

FACTUAL REPORT ON SITE INVESTIGATION

1. INTRODUCTION

On the instructions and under the supervision of, British Gas plc, the Employer and the Engineer, a site investigation has been carried out by Foundation and Exploration Services Limited (FES) at Aldbrough, East Yorkshire, on the site of a proposed exploratory drilling site and gas storage installation.

The object of the investigation was to determine the ground conditions at the site and to provide information that would assist the Engineer in the design of the foundations and earthworks. The scope of the investigation was determined by the Engineer. A factual report was requested.

The site work consisting of eleven trial pits was carried out on the 23rd July and the 24th July 1992.

2. THE SITE AND GEOLOGY

The site is located approximately 18 kilometres north east of Kingston-upon-Hull and 2.5 kilometres south east of Aldbrough village, East Yorkshire (Figure 26).

The approximate National Grid Reference of the site is TA 259 368.

At the time of the investigation the site occupied some forty acres of gently undulating arable farmland to the east of the B1242 Hornsea to Withernsea road.

The records of the British Geological Survey (The Southern Sheet of the 1:625,000 Series Geological Map, Drift and Solid Editions), indicate that the site is underlain by Boulder Clay with the Upper Chalk (Cretaceous Age) at depth.

Further background research in the form of a desk study was not required within the terms of reference for the work.

3. PROPOSED DEVELOPMENT

It is proposed to construct an exploratory deep drilling installation on the site of proposed gas storage facilities. Gas storage would be in underground cavities leached from salt bearing strata at depth.

4. METHOD OF INVESTIGATION

Eleven trial pits were excavated by mechanical means to depths of between 1.00m and 3.40m, at positions determined by the Engineer. They were logged on site by a Geotechnical Engineer, representative samples were taken and insitu testing was carried out as shown on the trial pit records (Figures 1 to 11).

The positions of the trial pits were set out by reference to features shown on the site plan.

5. RESULTS OF THE TRIAL PITS

5.1 General

Trial pit records (Figures 1 to 11) giving details of the strata encountered are given later in the report. A site plan showing the approximate positions of the trial pits is presented in Figure 27.

Any interpolation of strata between exploratory holes on the plans is an estimate only of the likely stratification and is subject to the interpretation of the reader. The description of ground conditions that follows is based on the results of the trial pits and the field and laboratory testing carried out. There may be ground conditions at the site which have not been revealed by the investigation.

Trial Pits 1 to 10 proved a 0.20m to 0.35m thickness of topsoil over Glacial Till materials to completion depths of between 1.00m and 3.40m below ground level (b.g.l.). Trial Pit 11 taken out within the access track, proved a 0.50m thickness of Made Ground over Glacial Till to completion at 1.00m depth.

5.2 Made Ground

Made Ground was encountered in Trial Pit 11 to 0.50m depth and consisted of granular pavement construction materials including bituminous tarmacadam road scalping, gravel and cobbles with varying proportions of brown sandy silty clay matrix.

5.3 Glacial Till

In general these deposits consisted of a sequence of firm, stiff and very stiff clays with widely varying sand and gravel contents, interbedded with medium dense and dense sand and gravel horizons. Trial Pit 6, proved a 0.40m thickness of loose clayey silty sand with many black and brown partially decomposed plant fragments from 2.10m to 2.50m depth.

5.4 Groundwater

A slight water seepage was encountered in Trial Pit 6 below 2.10m all other trial pits were dry on completion of excavation.

6. LABORATORY TESTING

6.1 Introduction

The following laboratory tests were scheduled by the Engineer and carried out in accordance with BS 1377 (1990) "Methods of Test for soils for Civil Engineering Purposes" where applicable. The results are given in tabular and/or graphical form as appropriate in a later section of the report.

6.2 Natural Moisture Content

The natural moisture content of twenty five samples was determined. The results are given on the Summary of Classification Tests (Figures 12 to 15).

6.3 Index Properties

Liquid and plastic limit determinations were made on three samples and the results are given on the Summary of Classification Tests (Figures 12 to 15).

6.4 Mechanical Analyses

One mechanical analysis by sieving has been carried out and the results are given as the particle size distribution curve, Figure 16.

6.5 Compaction Tests

Compaction tests to determine the optimum moisture content and maximum dry density were carried out on four samples. Two of the tests were carried out using the 2.5kg rammer method and two tests used the 4.5kg rammer method. The results are given graphically in Figures 17 to 20.

6.6 California Bearing Ratio Tests

California Bearing ratio (CBR) tests were carried out on three undisturbed samples and one sample recompacted in a CBR mould at natural moisture content. The results are given in Figures 21 to 24.

6.7 Chemical Analyses

Chemical analyses have been made on two samples of soil to determine their pH values and sulphate contents.

The results are given in the Summary of Chemical Analyses (Figure 25).

J. SHEARN
SENIOR ENGINEER

H. A. Hopgood p.p.
A. HELMORE
PRINCIPAL ENGINEER

FOUNDATION & EXPLORATION SERVICES LIMITED

NOTES

1 OPERATING PROCEDURES

The procedures used for cable percussion boring, rotary drilling, trial pitting, sampling, in-situ and laboratory testing and sample descriptions are generally in accordance with BS 5930 (1981) 'Site Investigations', and BS 1377 (1975) 'Methods of Test for Soils for Civil Engineering Purposes', unless stated otherwise.

2 GROUNDWATER

Borehole or trial pit water levels are recorded together with the depths at which seepages or inflows of water are detected and the observations are noted on the Records. These observations may be misleading for the following reasons:

a) The borehole or trial pit is rarely left standing at the relevant depth for a sufficient time for the water level to reach equilibrium.

b) A permeable stratum may have been sealed off by the borehole casing.

c) Water may have been added to the borehole to facilitate progress.

Standpipes or piezometers should be installed when an accurate record of groundwater level is required, however, it should be noted that groundwater levels vary due to seasonal, climatic or man-made effects. Water levels recorded during the investigation therefore may no longer be appropriate.

3 INTERPRETATION OF THE RESULTS OF THE INVESTIGATION

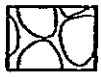
The description of ground conditions encountered and any engineering interpretation included in the report are based on the results of the boreholes and trial pits and the field and laboratory testing carried out. There may be ground conditions at the site which have not been revealed by the investigation and consequently have not been taken into account.

Any interpolation or extrapolation of strata between exploratory holes shown on cross-sections or site plans is an estimate only of the likely stratification based on general experience of the ground conditions and is subject to the interpretation of the reader.

KEY TO BOREHOLE AND TRIAL PIT RECORDS
Sheet 1 - Explanation of Symbols Used

SOIL TYPES

Coarse Grained, Non-Cohesive

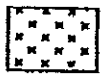
 Boulders

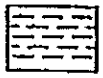
 Cobbles

 Gravel

 Sand

Fine Grained, Cohesive

 Silt

 Clay

Other Soil Types

 Top Soil

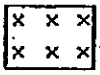
 Peat

 Made Ground

ROCK TYPES

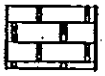
Sedimentary

 Sandstone

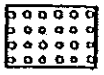
 Siltstone

 Mudstone/Claystone

 Shale

 Chalk

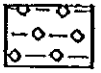
 Limestone

 Conglomerate

 Breccia

 Coal

 Pyroclastic (volcanic ash)

 Gypsum

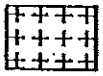
Metamorphic

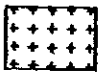
 Coarse-grained

 Medium-grained

 Fine-grained

Igneous

 Coarse-grained

 Medium-grained

 Fine-grained

NOTE: Composite soil or rock types are signified by combined symbols.

SOIL SAMPLES

U	Undisturbed general purpose sample (0.1m diameter and 0.45m long)
U(X)	Undisturbed sample (X) mm diameter
P(X)	Undisturbed piston sample (X) mm diameter
*	Sample not recovered

Depths are given to the top of undisturbed samples if full penetration and recovery are achieved, otherwise actual lengths of penetration and recovery are given:

e.g. 4.00 - 4.35m - indicates that the sample was driven 0.35m, but recovered 0.25m of sample (0.25m rec)

D	Small disturbed sample (jar with air tight lid - approximately 0.5kg)
B	Bulk disturbed sample (polythene bag tied with string - size dependent on purpose)
W	Water Sample
↑	Groundwater encountered

KEY TO BOREHOLE AND TRIAL PIT RECORDS

Sheet 2A: Identification and Description of Soils

SOILS

Basic Soil Type	Particle Size, mm	Visual Identification
BOULDERS	200	Only seen complete in pits or exposures.
COBBLES	60	Often difficult to recover from boreholes.
GRAVELS	coarse 20 / medium 6 / fine 2	Easily visible to naked eye; particle shape can be described; grading can be described. Well graded: wide range of grain sizes, well distributed. Poorly graded: not well graded. (May be uniform: size of most particles lies between narrow limits; or gap graded: an intermediate size of particle is markedly under-represented).
SANDS	coarse 0.6 / medium 0.2 / fine 0.06	Visible to naked eye; very little or no cohesion when dry; grading can be described. Well graded: wide range of grain sizes, well distributed. Poorly graded: not well graded. (May be uniform: size of most particles lies between narrow limits; or gap graded: an intermediate size of particle is markedly under-represented).
SILTS	coarse 0.02 / medium 0.006 / fine 0.002	Only coarse silt barely visible to naked eye; exhibits little plasticity and marked dilatancy; slightly granular or silky to the touch. Disintegrates in water; lumps dry quickly; possess cohesion but can be powdered easily between fingers.
CLAYS		Dry lumps can be broken but not powdered between the fingers; they also disintegrate under water but more slowly than silt; smooth to the touch; exhibits plasticity but no dilatancy; sticks to the fingers and dries slowly; shrinks appreciably on drying usually showing cracks. Intermediate and high plasticity clays show these properties to a moderate and high degree, respectively.
ORGANIC CLAY, SILT or SAND	Varies	Contains substantial amounts of organic vegetable matter.
PEATS		Predominantly plant remains usually dark brown or black in colour, often with distinctive smell; low bulk density.

Particle Nature and Plasticity
Particle shape: Angular Subangular Subrounded Rounded Flat Elongate Texture: Rough Smooth Polished
Non-plastic or low plasticity
Intermediate plasticity (Lean clay) High Plasticity (Fat clay)

Composite Soil Types (Mixtures of basic soil types)

Scale of secondary constituents with coarse and very coarse soils. Term either before or after principal constituent.

Term before	Principal	Term after	Approx % Secondary
Slightly (sandy*)	SAND, GRAVEL, COBBLES or BOULDERS	With a little (sand*) or occasional (cobbles+)	<5
— (sandy*)		With some (sand*) or some (cobbles+)	5 to 20+
Very (sandy*)		With much (sand*) or many (cobbles+)	20+ to 40+
—		and (sand*) or and (cobbles+)	50+

*Fine or coarse soil type as appropriate
+Very coarse soil type as appropriate
†Or described as fine soil depending on mass behaviour

Scale of secondary constituents with fine soils. Terms either before or after principal constituent.

Term before	Principal	Term after	Approx % Secondary
Slightly (sandy*)	CLAY or SILT	With a little (sand*)	< 35
— (sandy*)		With some (sand*)	35 to 65
Very (sandy*)		With much (sand*)	> 65†

*Coarse soil type as appropriate
+Or described as coarse soil depending on mass behaviour

Examples of composite types

(Indicating preferred order for description)

Loose, brown, very sandy, subangular coarse GRAVEL with small po[illegible] of soft grey clay.

Firm, brown [illegible] minated SILT and CLAY.

Dense light b[illegible] layey, fine and medium SAND.

Compactness/Strength

Term	Field Test
Loose	By inspection of voids and particle packing
Dense	

Excavation or Exposure

Loose	Can be excavated with a spade; 50mm wooden peg can be easily driven
Dense	Requires pick for excavation; 50mm wooden peg hard to drive
Slightly cemented	Visual examination; pick removes soil in lumps which can be abraded

Standard Penetration Test in Borehole

No. of Blows	Relative Density
0 - 4	Very loose
4 - 10	Loose
10 - 30	Medium dense
30 - 50	Dense
> 50	Very dense

Soft or Loose	Easily moulded or crushed in the fingers.	
Firm or dense	Can be moulded or crushed by strong pressure in the fingers	
Very soft	Exudes between fingers when squeezed in hand	Cohesion (kN/m²) < 20
Soft	Moulded by light finger pressure	20 to 40
Firm	Can be moulded by strong finger pressure	40 to 75
Stiff	Cannot be moulded by fingers. Can be indented by thumb	75 to 150
Very stiff	Can be indented by thumb nail	> 150
Firm	Fibres already compressed together	
Spongy	Very compressible and open structure	
Plastic	Can be moulded in hand and smears fingers	

Structure

Term	Field Identification
Homogeneous	Deposit consists essentially of one type
Interstratified	Alternating layers of varying types or with bands or lenses of other materials Interval scale for bedding spacing may be used.
Heterogeneous	A mixture of types
Weathered	Particles may be weakened and may show concentric layering
Fissured	Breaks into polyhedral fragments along fissures. Interval scale for spacing of discontinuities may be used.
Intact	No fissures
Homogeneous	Deposit consists essentially of one type
Interstratified	Alternating layers of varying types. Interval scale for thickness of layers may be used.
Weathered	Usually has crumb or columnar structure.
Fibrous	Plant remains recognisable and retain some strength
Amorphous	Recognisable plant remains absent

Scale of Bedding Spacing	
Term	Mean spacing, mm
Very thickly bedded	over 2000
Thickly bedded	2000-600
Medium bedded	600-200
Thinly bedded	200-60
Very thinly bedded	60-20
Thickly laminated	20-6
Thinly laminated	under 6

Scale of spacing of other discontinuities	
Term	Mean spacing, mm
Very widely spaced	over 2000
Widely Spaced	2000-600
Medium spaced	600-200
Closely spaced	200-60
Very closely spaced	60-20
Extremely closely spaced	20

KEY TO BOREHOLE AND TRIAL PIT RECORDS

Sheet 2B: Notes to Accompany Sheet 2A
Identification and Description of Soils

1. The identification system is based on Table 6, BS 5930 : 1981.
2. Composite soil type descriptions have been amended in accordance with Norbury et al, A critical review of Section 8 (BS 5930) - Soil and Rock Description. Engineering Group of the Geological Society, 20th Regional Meeting, September, 1984.
3. The strength descriptions have been amended to include Standard Penetration Test interpretation of relative density, and cohesion ranges added to field identification of clay shear strengths.
4. The sub-divisions of strength for cohesive soils (BS 5930: 1981 pp103) are not used. Where the terms 'soft to firm', 'firm to stiff' etc are used they indicate a strength based on inspection (and not supported by laboratory testing) which is on or close to the borderline between the two terms and cannot be precisely defined by inspection only.
5. Where 'to' links two terms, as in 'slightly sandy to sandy' this again represents a borderline case, where the precise proportion of constituents cannot be determined by inspection only.

KEY TO BOREHOLE AND TRIAL PIT RECORDS

Sheet 3: In-Situ Testing

S( ) Standard Penetration Test (SPT). A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.60kg hammer with a 760mm drop, and the penetration resistance ( ) is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole.

The depth on the borehole record is that at the start of the normal 450mm penetration. The number of blows to achieve the standard penetration of 300mm (the N-value) is shown after the test index letter, but the seating blows through the initial 150mm penetration are not reported unless the full penetration of 450mm is not achieved. In this case the symbols below are added.

S(65/125mm) Denotes penetration of first 125mm of test section for 65 blows.

S(65/init 115mm) Denotes penetration of initial 115mm of the 150mm seating section for 65 blows.

The test is usually completed when the number of blows reaches 50.

If a sample is not recovered in the split barrel sampler, a disturbed sample is taken on completion of the test. Both are given the same depth as the top of the Standard Penetration Test drive.

C( ) Standard Penetration Test carried out with a 60° cone. A test usually conducted in coarse granular soils using the same procedure as for the SPT, but with a 50mm, 60° apex solid cone fitted to the split barrel. Variations in test results are indicated by the same symbols as for the SPT. The bulk disturbed sample taken is given the same depth as the top of the test drive.

VN( ) Vane Test (natural shear strength kN/m^2)

VR( ) Vane Test (remoulded shear strength kN/m^2)

ID( ) Insitu Density Test (Density Mg/m^3)

K( ) Insitu Permeability Test (Permeability m/sec)

PMT Pressuremeter Test

CBR California Bearing Ratio Test

PBT Plate Bearing Test

} Please refer to the report for details and results.

RECORD OF TRIAL PIT NO: 1

...YORKSHIRE SALT CAVITY

...N: ...ROUGH, EAST YORKSHIRE.

CT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 2.50m

START DATE: 23/7/92 FINISH DATE:

CO-ORDINATES: E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

...SITU TESTING ...n) Type	Result	SAMPLES Depth (m)	Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
					TOPSOIL: Dark brown, silty, very sandy (fine to medium, occasionally coarse) CLAY, with a little fine to medium, occasionally coarse, subangular to rounded gravel.	(0.30)	0.30		
HV	32,46,110	0.70 1.00 0.70 0.70	B CBR D	1 2	Compact? brown, fine to medium SAND, with occasional coarse sand. Below 0.80m grading to generally red-brown, fine to coarse sand, very weakly cemented and with a little fine to medium, occasionally coarse, subangular to rounded gravel. (GLACIAL TILL)	(0.70)	1.00		
HV	140+,140+				END OF TRIAL PIT				

1 The excavation was dry and stable on completion.
2 On completion the excavation was backfilled with compacted arisings

PLAN

185°

Logged by: JS

Date: 24/7

Checked by:

Approved by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: EAST YORKSHIRE SALT CAVITY

ION: ALDBROUGH, EAST YORKSHIRE.

RACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 2.60m

START DATE: 23/7/92 FINISH DATE:

RECORD OF TRIAL PIT NO: 2

CO-ORDINATES:
E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

INSITU TESTING			SAMPLES			DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.o.d.)	Strata Symbol
(m)	Type	Result	Depth (m)	Type	No.					
						TOPSOIL: Dark brown, clayey to very clayey, silty fine SAND, with some medium to coarse sand and a little fine to coarse subangular to rounded gravel.	(0.35)	0.35		
			0.80 1.00 0.90 0.80	B CBR D	1 2	Very compact? brown, mottled light brown, fine to coarse, subrounded to rounded, occasionally subangular, GRAVEL, with /much brown, silty, fine to coarse sand, slightly clayey in parts. Traces of white lime at 0.70m. Very dry. (GLACIAL TILL)	(0.65)	1.00		
						END OF TRIAL PIT				

KS:
1. Three attempts to take an undisturbed CBR sample at 0.80m failed due to the coarse granular nature of the soil.
2. The excavation was dry and stable on completion.
3. On completion the excavation was backfilled with compacted arisings.

PLAN

Logged by:	Date:
JS	24/7
Checked by:	
Approved by:	

FOUNDATION & EXPLORATION SERVICES

FIGURE:

RECORD OF TRIAL PIT NO: 3

T: T YORKSHIRE SALT CAVITY

ON: ALDBROUGH, EAST YORKSHIRE.

ACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 2.20m

START DATE: 23/7/92 FINISH DATE:

CO-ORDINATES: E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

IN SITU TESTING (m)	Type	Result	SAMPLES Depth (m)	Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
						TOPSOIL: Dark brown, sandy (fine, occasionally medium to coarse), silty CLAY, with rootlets and a little fine to coarse gravel.	(0.35)	0.35		
			0.70 0.70 0.70	1.00 B CBR D	2 1 3	Stiff? orange/orange-brown, sandy (fine to medium, occasionally coarse), silty CLAY with some coarse sand and a little fine to coarse, subangular to rounded gravel. Below about 0.60m grades to become very sandy and with some gravel. (GLACIAL TILL)	(0.65)	1.00		
						END OF TRIAL PIT				

S: 1. The excavation was dry and stable on completion.
2. On completion the excavation was backfilled with compacted arisings.

PLAN

048°

Logged by: JS

Date: 24/7

Checked by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: EAST YORKSHIRE SALT CAVITY

ION: ALDBROUGH, EAST YORKSHIRE.

RACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 2.70m

START DATE: 23/7/92 FINISH DATE:

RECORD OF TRIAL PIT NO: 4

CO-ORDINATES:
E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

INSITU TESTING (m)	Type	Result	SAMPLES Depth (m)	Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
						Dark brown, slightly sandy (fine, occasionally medium to coarse), silty CLAY, with rootlets and a little fine to coarse, subangular to rounded gravel.	(0.30)			
	HV	140+				Very stiff, dark brown, sandy (fine, little medium to coarse), silty CLAY, with some fine to coarse, subangular to rounded gravel. Very closely to extremely closely fissured, dessicated. (GLACIAL TILL)	(0.15)	0.30 0.45		
						Gradational change from 0.45m to 0.65m to:- Very compact orange/orange brown, slightly clayey, silty, fine to medium SAND, with some coarse sand and a little fine to coarse, subangular to rounded gravel.				
	HV	140+				Gravel content increases with depth, becoming sand below about 1.00m, much below about 1.20m and grading to sand and gravel below about 1.60m.				
						Below about 2.00m grades to gravel with much sandy (fine to coarse), silty clay.				
						(GLACIAL TILL)	(1.95)			
			2.00 2.00 2.40	B D	2 1					
								2.40		
						END OF TRIAL PIT				

KS:
1. A 65mm I.D. clay pipe land drain was encountered at 0.80m depth.
2. The excavation was dry and stable on completion.
3. On completion the excavation was backfilled with compacted arisings.

PLAN

136

Logged by: JS

Date: 24/7

Checked by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: ST YORKSHIRE SALT CAVITY

ON: ALDBROUGH, EAST YORKSHIRE.

ACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 2.50m

START DATE: 23/7/92 FINISH DATE:

RECORD OF TRIAL PIT NO: 5

CO-ORDINATES: E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

INSITU TESTING (m)	Type	Result	SAMPLES Depth (m)		Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.o.d.)	Strata Symbol
							TOPSOIL: Brown very sandy (fine, occasionally medium to coarse), silty CLAY, with rootlets and occasional fine to coarse, subangular to rounded gravel.	(0.35)	0.35		
	HV	107,140+,14	0.50 0.50	0.70	B D	2 1	Stiff to very stiff, friable, brown mottled orange-brown and grey-brown slightly sandy (fine, occasionally medium to coarse), silty CLAY, with a little fine to coarse subangular to rounded gravel. Very closely to extremely closely fissured with roothairs along fissures. (GLACIAL TILL)	(0.45)	0.80		
	HV	Too dense					Very compact? orange, mottled grey-brown and brown, slightly clayey, silty, fine to medium SAND, some coarse sand and some fine to medium, little coarse, subangular to rounded gravel. Becoming much gravel below about 1.10m. Occasional cobbles. Locally grades to sandy silty clay. (GLACIAL TILL)				
			1.50 1.50	1.60	B D	4 3		(1.30)			
	HV	92,100,117	2.10 2.10	2.20	B D	6 5	Stiff, dark brown, silty CLAY, with a little fine to coarse sand and a little fine, subangular to rounded gravel. (GLACIAL TILL)	(0.10)	2.10 2.20		
							END OF TRIAL PIT				

S: 1. The excavation was dry and stable on completion.
2 On completion the excavation was backfilled with compacted arisings.

PLAN

136°

Logged by: JS Date: 24/7

Checked by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

ECT: EAST YORKSHIRE SALT CAVITY

METHOD OF EXCAVATION: MECHANICAL

RECORD OF TRIAL PIT NO: 6

TION: ALDBROUGH, EAST YORKSHIRE.

SURFACE DIMENSIONS OF PIT: 0.70m x 3.20m

CO-ORDINATES:

Sheet 1 of 1

RACT NO: 2172

START DATE: 24/7/92 FINISH DATE:

E: N:

GROUND LEVEL: m.O.D.

INSITU TESTING			SAMPLES			DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.o.d.)	Strata Symbol
(m)	Type	Result	Depth (m)	Type	No.					
						TOPSOIL: Dark brown, silty CLAY, with rootlets. Trace of fine to coarse sand and fine to medium gravel.	(0.25)	0.25		
0	HV	34,58,58	0.40 0.40	B D	1 2	Firm, locally soft, grey and light brown/orange-brown mottled,closely fissured, slightly sandy (fine, occasionally medium to coarse), silty CLAY, with a trace of fine to medium subangular to rounded gravel. (GLACIAL TILL)	(0.40)	0.65		
	HV	62,70,96	1.00 1.00	B D	3 4	Firm, locally stiff, light brown, mottled grey, slightly sandy silty CLAY, with a little fine to medium, occasionally coarse, gravel. Occasional cobbles. Mottled orange-brown in parts and with some thin bands (20mm to 100mm) of very silty clay/ clayey silt. Below 1.20m becomes generally grey, mottled light brown and orange-brown. (GLACIAL TILL)	(1.45)	2.10		
	HV	21,18,18	2.20 2.20	B D	5 6	Loose, red brown, clayey, silty, fine SAND, with many black and brown partially decomposed plant fragments. With lenses of very silty sand and sandy clay. (GLACIAL TILL)	(0.40)	2.50		
			2.60 2.60	B D	7 8	Compact? grey-brown, fine to coarse SAND and fine to medium, subangular to rounded GRAVEL, with a little coarse gravel and occasional cobbles. With pockets of silty clay in parts. Grades below about 2.80m into gravel with some/much sand. (GLACIAL TILL)	(0.90)	3.40	-3.40m	
						END OF TRIAL PIT				

RKS:
1. A slight seepage of ground water was encountered below 2.10m depth.
2. The excavation was unstable with minor spalling occuring from 2.10m to 2.50m depth. At 3.40m depth the west face of the trial pit collapsed below 2.10m due to instability of the underlying gravels The excavation was therefore terminated at 3.40m de
3. On c ion the excavation was backfilled with compacted ar

PLAN

195°

Logged by: JS

Date: 24/7

Checked by:

Approved by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: T YORKSHIRE SALT CAVITY

ION: ALDBROUGH, EAST YORKSHIRE.

ACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 3.00m

START DATE: 24/7/92 FINISH DATE:

RECORD OF TRIAL PIT NO: 7

CO-ORDINATES: E: N:

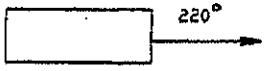
Sheet 1 of 1

GROUND LEVEL: m.O.D.

INSITU TESTING (m)	Type	Result	SAMPLES Depth (m)		Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
							TOPSOIL: Dark slightly grey-brown, slightly sandy, silty CLAY, with rootlets.	(0.20)	0.20		
	HV	35,62,48	0.40 0.40	0.60	B D	1 2	Firm, locally soft, light brown, orange-brown and grey mottled, silty CLAY, with a trace of fine to coarse sand and fine gravel. (GLACIAL TILL)	(0.40)	0.60		
	HV	93,98,134	0.80 0.80	1.00	B D	3 4	Stiff, orange/orange-brown, mottled grey, slightly sandy (fine), silty CLAY, with a trace of medium to coarse sand and a little fine to coarse, subangular to rounded gravel. (GLACIAL TILL)	(0.50)	1.10		
	HV	80,72,82	1.20 1.20	1.40	B D	5 6	Stiff, grey, mottled orange, silty CLAY, with pockets of orange, sandy (fine to medium) silty clay. Occasional roothairs on medium spaced fissures down to 1.40m. (GLACIAL TILL)	(0.30)	1.40		
	HV	140+	2.00	2.20	B	7	Probably very stiff, red brown, mottled grey, slightly sandy (fine to medium occasionally coarse), silty CLAY, with a little fine to coarse, subangular to rounded gravel and occasional cobbles. (GLACIAL TILL)	(1.30)	2.70		
			2.20		D	8	END OF TRIAL PIT				

S: 1. The excavation was dry and stable on completion.
2. On completion the excavation was backfilled with compacted arisings.

PLAN



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JS	24/7
Checked by:	

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: EAST YORKSHIRE SALT CAVITY

ION: ALDBROUGH, EAST YORKSHIRE.

ACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 3.20m

START DATE: 24/7/92 FINISH DATE:

RECORD OF TRIAL PIT NO: 8

CO-ORDINATES: E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

INSITU TESTING (m)	Type	Result	SAMPLES Depth (m)		Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
							TOPSOIL: Dark brown, silty CLAY, with rootlets. Trace of fine sand and fine to coarse gravel.	(0.25)	0.25		
	HV	35,54,40	0.40 0.40	0.60	B D	1 2	Soft, locally firm, grey and light brown mottled, silty CLAY, with a trace of fine to coarse sand and fine gravel. 40mm I.D. clay pipe land drain encountered at 0.55m depth. (GLACIAL TILL)	(0.35)	0.60		
	HV	140+					Very stiff, dessicated? red-brown, mottled grey, closely fissured, slightly sandy (fine, occasionally medium to coarse), silty CLAY, with a little fine to coarse, subangular to rounded gravel and occasional cobbles. (GLACIAL TILL)	(1.90)			
			1.20 1.20	1.40	B D	3 4					
							END OF TRIAL PIT		2.50		

S 1. The excavation was dry and stable on completion.
2 On completion the excavation was backfilled with compacted arisings

PLAN

Logged by:	Date:
JS	24/7
Checked by:	
Approved by:	

FOUNDATION & EXPLORATION SERVICES

FIGURE:

T: YORKSHIRE SALT CAVITY

METHOD OF EXCAVATION: MECHANICAL

RECORD OF TRIAL PIT NO: 9

ON: ALDBROUGH, EAST YORKSHIRE.

SURFACE DIMENSIONS OF PIT: 0.70M X 3.20M

CO-ORDINATES:

Sheet 1 of 1

CT NO: 2172

START DATE: 24/7/92 FINISH DATE:

E: N:

GROUND LEVEL: m.O.D.

IN SITU TESTING			SAMPLES			DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
m)	Type	Result	Depth (m)	Type	No.					
						TOPSOIL: Dark brown, slightly sandy (fine), very silty CLAY, with rootlets and a little fine to coarse, subangular to rounded gravel.	(0.25)	0.25		
	HV	108,60,85	0.40 0.40	B D	1 2	Stiff, locally firm, light brown/yellow brown, slightly sandy (fine to mdium, occasionally coarse), silty CLAY, with a little fine to coarse, subangular to rounded gravel. (GLACIAL TILL)	(0.25)	0.50		
	HV	140+				Very stiff, red-brown, mottled grey, slightly sandy (fine, little medium to coarse), silty CLAY, with a little fine to coarse, subangular to rounded gravel. Occasional cobbles. Discoloured grey along medium spaced fissures. Occasional rootlairs on fissures down to 1.40m.				
			1.00 1.00	B D	3 4	(GLACIAL TILL)	(2.00)	2.50		
						END OF TRIAL PIT				

1. The excavation was dry and stable on completion
2. On completion the excavation was backfilled with compacted arisings

PLAN

190°

Logged by:	Date:
JS	24/7
Checked by:	

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: EAST YORKSHIRE SALT CAVITY

ON: ALDBROUGH, EAST YORKSHIRE.

ACT NO: 2172

METHOD OF EXCAVATION: MECHANICAL

SURFACE DIMENSIONS OF PIT: 0.70m x 2.90m

START DATE: 24/7/92 FINISH DATE:

RECORD OF TRIAL PIT NO: 10

CO-ORDINATES:

E: N:

Sheet 1 of 1

GROUND LEVEL: m.O.D.

INSITU TESTING (m)	Type	Result	SAMPLES Depth (m)		Type	No.	DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.O.D.)	Strata Symbol
							TOPSOIL: Dark brown, slightly sandy (fine, occasionally medium to coarse), silty CLAY, with rootlets. Trace of fine to coarse gravel.	(0.30)	0.30		
	HV	140+,136,14					Stiff, becoming very stiff below about 0.50m, friable, red-brown, mottled grey-brown and yellow-brown, slightly sandy (fine, occasionally medium to coarse), silty CLAY, with a little fine to medium, occasionally coarse, subangular to rounded gravel. Discoloured grey along medium spaced fissures.				
			0.80 0.80	0.90	B D	1 2	(GLACIAL TILL)				
	HV	140+						(2.20)			
			1.90 1.90	2.00	B D	3 4					
									2.50		
							END OF TRIAL PIT				

S: 1. The excavation was dry and stable on completion.
2. On completion the excavation was backfilled with compacted arisings.

PLAN

27

Logged by: JS Date: 24/7

Checked by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

CT: T YORKSHIRE SALT CAVITY | METHOD OF EXCAVATION: MECHANICAL | RECORD OF TRIAL PIT NO: 11

ION: ALDBROUGH, EAST YORKSHIRE. | SURFACE DIMENSIONS OF PIT: 0.70m x 2.00m | CO-ORDINATES: | Sheet 1 of 1

ACT NO: 2172 | START DATE: 23/7/92 FINISH DATE: | E: N: | GROUND LEVEL: m.O.D.

INSITU TESTING			SAMPLES			DESCRIPTION OF STRATA	Thickness (m)	Depth (m)	Level (m.o.d.)	Strata Symbol
(m)	Type	Result	Depth (m)	Type	No.					
						MADE GROUND: Granular pavement construction material comprising tarmacadam road scalpings and subangular to rounded cobbles (up to 300 x 200 x 150mm seen), in a sparse matrix of grey and brown, slightly sandy silty clay. Bituminous and oily odour.	(0.30)	0.30		
						MADE GROUND: Brown, fine to medium, some coarse, subangular to well rounded gravel, with some/much brown, sandy (fine to coarse), silty clay matrix.	(0.20)	0.50		
	HV	80,86,72	0.70 0.70 0.70	1.00	B CBR D	1 1-2 2	Stiff, brown red-brown and light brown mottled silty CLAY, with a trace of fine to coarse sand. (GLACIAL TILL)	(0.50)	1.00		
						END OF TRIAL PIT				

S: 1. The excavation was dry and stable on completion.
2. On completion the excavation was backfilled with compacted arisings

PLAN

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Logged by: JS | Date: 24/7

Checked by:

FOUNDATION & EXPLORATION SERVICES

FIGURE:

SUMMARY OF SOIL CLASSIFICATION TESTS

B.S. 1377 : 1990 : Part 2

TRIAL PIT/SAMPLE NO	Type	Depth m	Bulk Density Mg/m³ Test 7.2	Moisture Content % Test 3.2	Dry Density Mg/m³ Test 7.2	Particle Density Mg/m³ Test 8.2/8.3/8.4	Liquid Limit % Test 4.3/4.4	Plastic Limit % Test 5.3	Plasticity Index Test 5.4	% Passing 425 µm	Method of Preparation	Description of Sample
TP1/2	D	0.70		8.3								Dark brown/orange sandy (fine to coarse) silty CLAY with a little fine gravel.
TP2/2	D	0.80		5.5								Brown sandy (fine to medium) silty CLAY with some fine to coarse gravel.
TP3/2	B	0.70		16			44	23	21	78	AD	Yellow-brown sandy (fine to coarse) silty CLAY with a little fine to coarse gravel.
TP3/3	D	0.70		18								Light brown sandy (fine) silty CLAY with a little fine gravel.
TP4/1	D	2.00		14								Light brown sandy (fine to medium) silty CLAY with some fine to medium gravel.
TP5/1	D	0.50		20								Grey-brown sandy (fine) silty CLAY with a little fine gravel.
TP5/3	D	1.50		7.9								Brown sandy (fine to medium) silty CLAY with a little fine to medium gravel.

SYMBOLS - NP: Non Plastic U:Undisturbed Sample D: Disturbed Sample B: Bulk Disturbed Sample A.R: As Received H.P: Hand Picking A.D: Air Drying W.S:Wet Sieving

FOUNDATION EXPLORATION

Compiled by	Date	Checked by	Date	Approved by	For Contractor		For Engineer	Date	CONTRACT No:
JDA	18/8/92								2

SUMMARY OF SOIL CLASSIFICATION TESTS

B.S. 1377 : 1990 : Part 2

AL PIT/SAMPLE NO	Type	Depth m	Bulk Density Mg/m³ Test 7.2	Moisture Content % Test 3.2	Dry Density Mg/m³ Test 7.2	Particle Density Mg/m³ Test 8.2/8.3/8.4	Liquid Limit % Test 4.3/4.4	Plastic Limit % Test 5.3	Plasticity Index Test 5.4	% Passing 425 µm	Method of Preparation	Description of Sample
5/5	D	2.10		20								Dark brown sandy (fine) silty CLAY with a little fine gravel.
6/2	D	0.40		39								Brown mottled sandy (fine) silty CLAY.
6/3	B	1.00		35			68	28	40	100	AR	Brown mottled sandy (fine) silty CLAY.
5/4	D	1.00		29								Brown sandy (fine) silty CLAY.
5/6	D	2.20		27								Dark brown/black sandy (fine to medium) silty CLAY.
5/8	D	2.60		13								Dark brown sandy (fine to coarse) silty CLAY with some fine to medium gravel.
7/2	D	0.40		45								Grey and brown mottled sandy (fine) silty CLAY.
7/4	D	0.80		27								Brown mottled sandy (fine) silty CLAY.

BOLS - NP: Non Plastic U:Undisturbed Sample D: Disturbed Sample B: Bulk Disturbed Sample A.R: As Received H.P: Hand Picking A.D: Air Drying W.S:Wet Sieving

DUNDATION	Compiled by	Date	Checked by	Date	Approved by	For Contractor	Date	For Engineer	Date	CONTRACT No: 2172
	TDA	18/8/92								

SUMMARY OF SOIL CLASSIFICATION TESTS

B.S. 1377 : 1990 : Part 2

TIAL PIT/SAMPLE NO	Type	Depth m	Bulk Density Mg/m³ Test 7.2	Moisture Content % Test 3.2	Dry Density Mg/m³ Test 7.2	Particle Density Mg/m³ Test 8.2/8.3/8.4	Liquid Limit % Test 4.3/4.4	Plastic Limit % Test 5.3	Plasticity Index Test 5.4	% Passing 425 μm	Method of Preparation	Description of Sample
P7/6	D	1.20		24								Grey sandy (fine) silty CLAY with a little fine gravel.
P7/8	D	2.20		19								Brown sandy (fine) silty CLAY with a little fine gravel.
P8/2	D	0.40		18								Brown sandy (fine) silty CLAY with a little fine gravel.
P8/4	D	1.20		15								Brown sandy (fine) silty CLAY with a little fine to medium gravel.
P9/2	D	0.40		28								Light brown sandy (fine) silty CLAY.
P9/3	B	1.00		15			42	23	19	94	HP	Brown sandy (fine) silty CLAY with a little fine gravel.
P9/4	D	1.00		14								Brown sandy (fine) silty CLAY with a little fine gravel.

SYMBOLS - NP: Non Plastic U:Undisturbed Sample D: Disturbed Sample B: Bulk Disturbed Sample A.R: As Received H.P: Hand Picking A.D: Air Drying W.S:Wet Sieving

FOUNDATION INVESTIGATION

Compiled by	Date	...d by	Date	Approved by	For Contractor		For Engineer	Date	CONTRACT No:
JDA	18/8/92								

SUMMARY OF SOIL CLASSIFICATION TESTS

B.S. 1377 : 1990 : Part 2

AL PIT/SAMPLE NO	Type	Depth m	Bulk Density Mg/m³ Test 7.2	Moisture Content % Test 3.2	Dry Density Mg/m³ Test 7.2	Particle Density Mg/m³ Test 8.2/8.3/8.4	Liquid Limit % Test 4.3/4.4	Plastic Limit % Test 5.3	Plasticity Index Test 5.4	% Passing 425 µm	Method of Preparation	Description of Sample
10/2	D	0.80		14								Brown sandy (fine) silty CLAY with a little fine gravel.
10/4	D	1.90		16								Brown sandy (fine) silty CLAY with a little fine gravel.
11/2	D	0.70		26								Brown sandy (fine) silty CLAY with a little fine gravel.

IOLS - NP: Non Plastic U:Undisturbed Sample D: Disturbed Sample B: Bulk Disturbed Sample A.R: As Received H.P: Hand Picking A.D: Air Drying W.S:Wet Sieving

UNDATION EXPLORATION

Compiled by	Date	Checked by	Date	Approved by	For Contractor	Date	For Engineer	Date	CONTRACT No:
JDA	18/8/92								2172

PARTICLE SIZE DISTRIBUTION

B.S. 1377 : Part 2 : 1990 : 9.2/~~9.3/9.4/9.6/9.7~~ *

BOREHOLE/SAMPLE No: TP4/2 TYPE: B

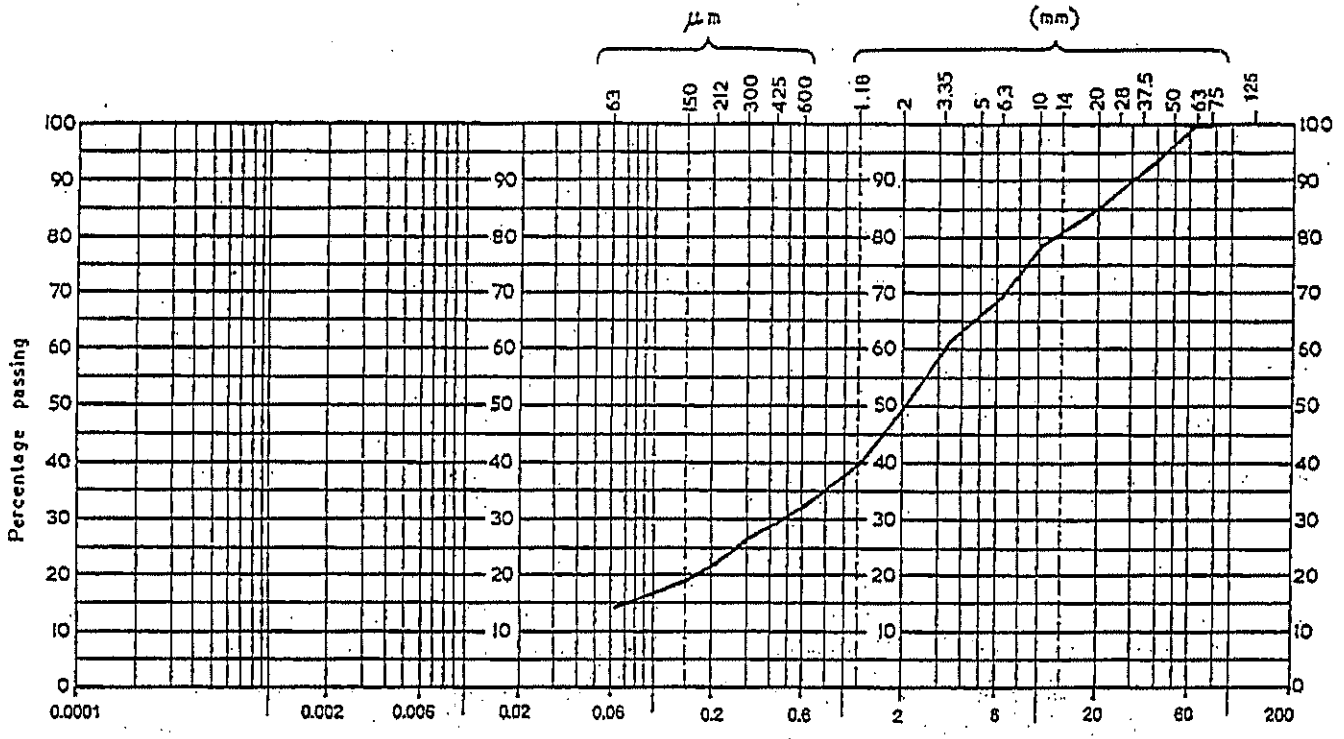
DEPTH: 2.00 m

SAMPLE DESCRIPTION: Brown fine to coarse GRAVEL with much sandy (fine to coarse) silty CLAY.

DATE OF TESTING: AUGUST 1992

LOSS ON PRETREATMENT: ..... METHOD: .....

METHOD OF PREPARATION: OVEN/~~AIR~~* DRIED



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Compiled by	Date	Checked by	Date	Approved by	For Contractor	For Engineer	Date	CONTRACT No:
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FOUNDATION EXPLORATION

COMPACTION TEST

B.S.1377: 1975: DRY DENSITY/MOISTURE CONTENT RELATIONSHIP TEST 12.

Borehole/Sample No: TP3/2 Depth (m): 0.70 Date: AUGUST 1992

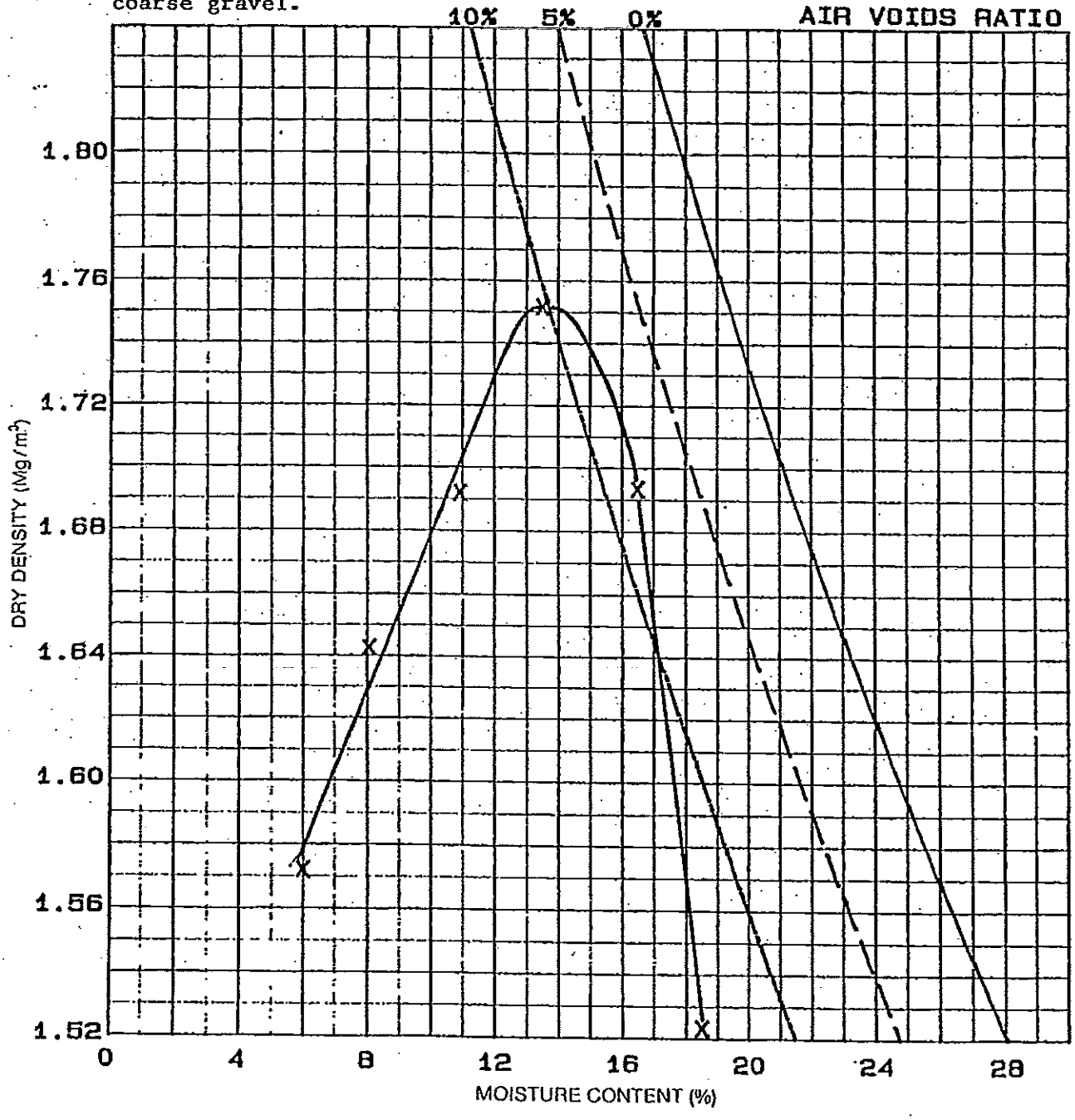
Type of Compaction: DYNAMIC 2.5 Kg.

Material Retained on: 20 mm BS Sieve (%): 8.5 Specific Gravity: 2.65 (ASSUMED)

Maximum Dry Density (Mg/m³): 1.75

Optimum Moisture Content (%): 13

Description: Yellow-brown, sandy (fine to coarse), silty CLAY with a little fine to coarse gravel.



Operator	TF	Date	3.8.92	Approved by	For Contractor	Date	For Engineer	Date
Checked by		Date	17.8.92					

FOUNDATION SERVICES

EAST YORKSHIRE SALT CAVITY
(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

COMPACTION TEST

B.S.1377: 1975: DRY DENSITY/MOISTURE CONTENT RELATIONSHIP TEST 13.

Borehole/Sample No: TP3/2 ..... Depth (m): 0.70 ..... Date: AUGUST 1992

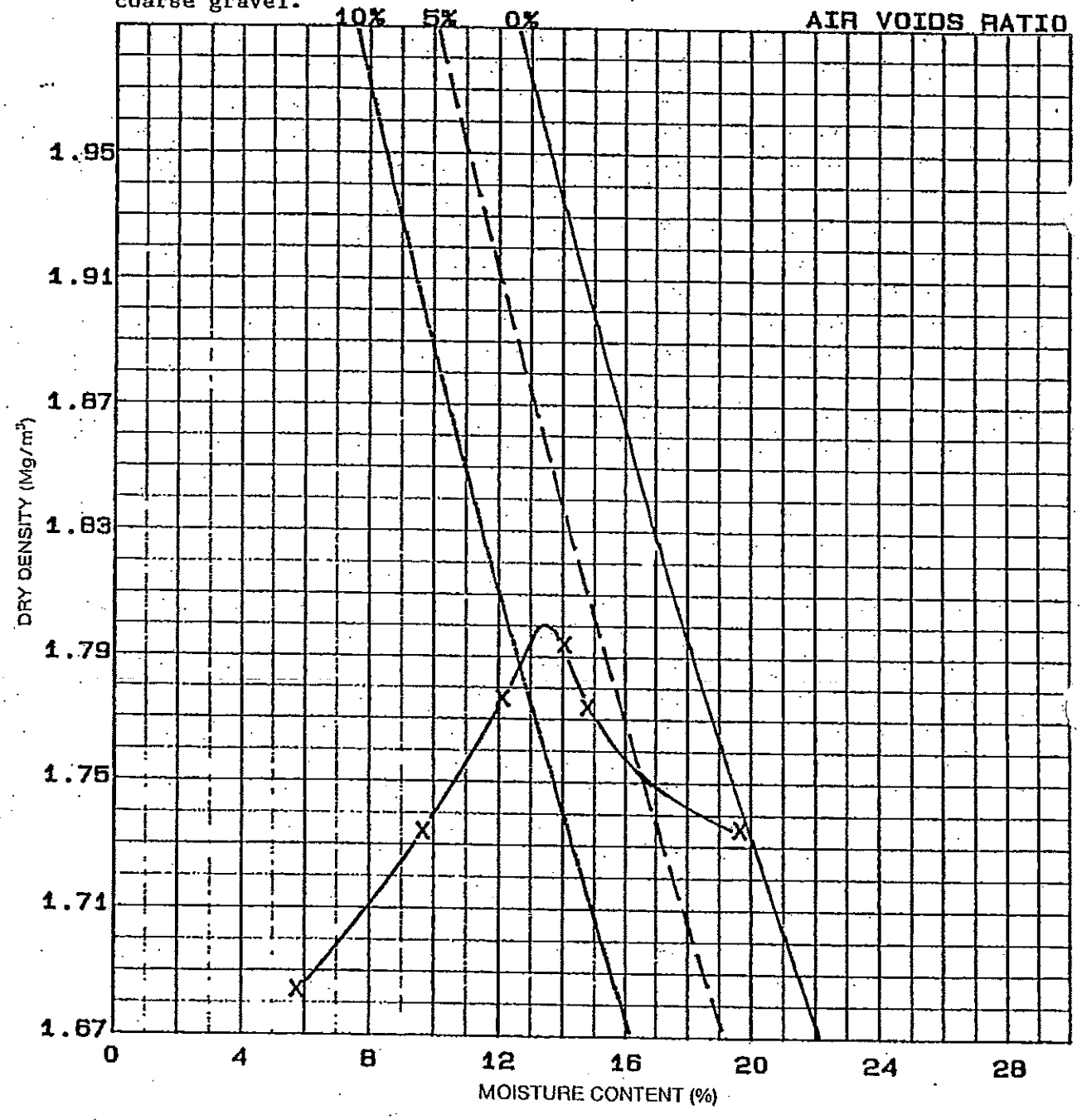
Type of Compaction: DYNAMIC 4.5 Kg.

Material Retained on: 20 mm BS Sieve (%): 8.8 Specific Gravity: 2.65 (ASSUMED)

Maximum Dry Density (Mg/m^3): 1.80

Optimum Moisture Content (%): 13

Description: Yellow-brown, sandy (fine to coarse), silty CLAY with a little fine to coarse gravel.



Operator	TF	Date	3.8.92	Approved by	For Contractor	Date	For Engineer
Checked by		Date	17.8.92				

FOUNDATION SERVICES

EAST YORKSHIRE SALT CAVITY

(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

FIGURE: 18

COMPACTION TEST

B.S.1377: 1975: DRY DENSITY/MOISTURE CONTENT RELATIONSHIP TEST 12.

Borehole/Sample No:. . TP4/2 . . . . Depth (m):. 2.00 . .. . Date: .....AUGUST .1992..... ..

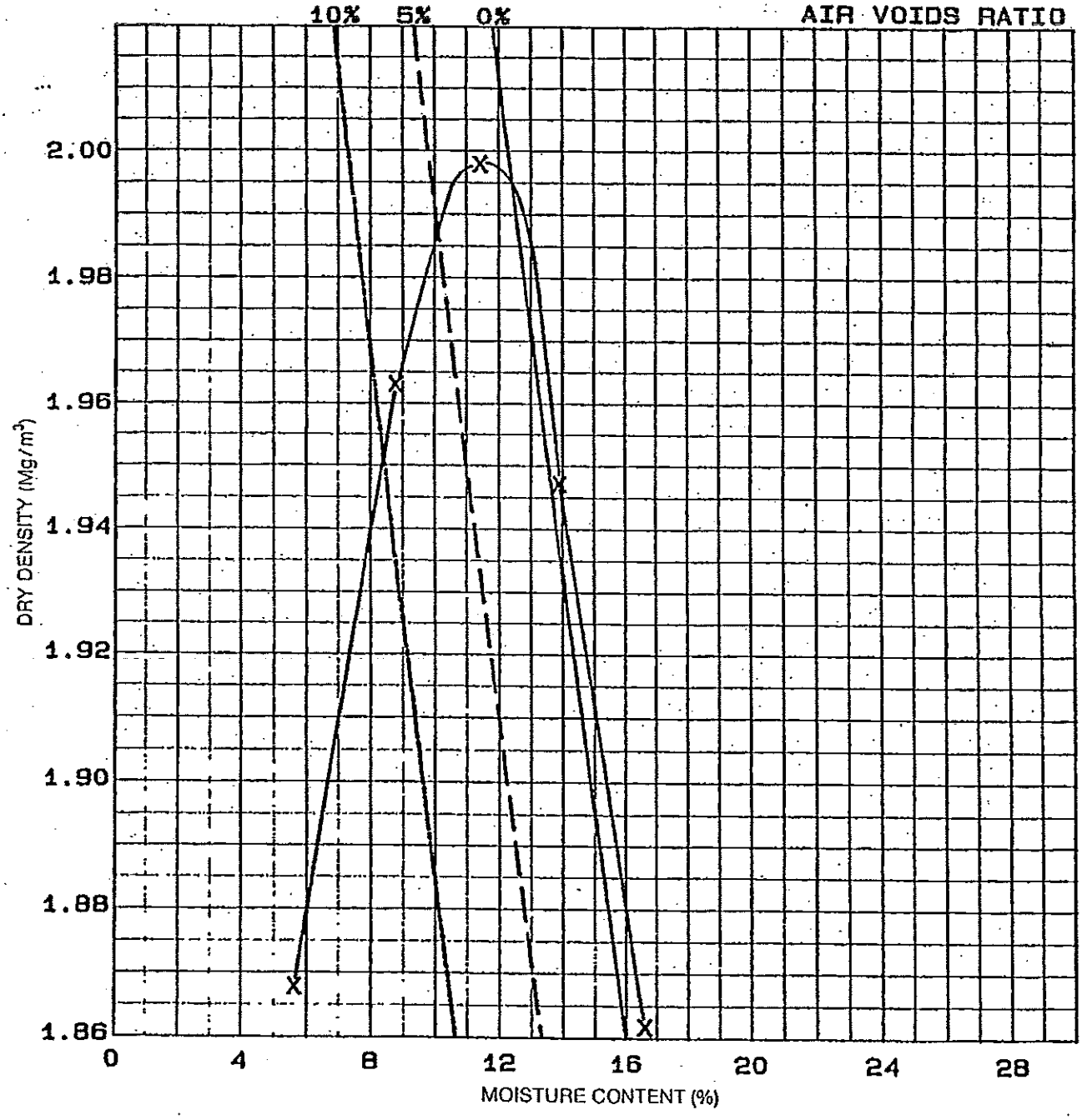
Type of Compaction: ..... DYNAMIC .2.5 .Kg..... ....

Material Retained on:. ....20 . ..mm BS Sieve (%) :....15..... Specific Gravity: ....2.65.....(ASSUMED).....

Maximum Dry Density (Mg/m^3) : .....2.00.....

Optimum Moisture Content (%) : .....11.....

Description: Brown, fine to coarse GRAVEL, with much sandy (fine to coarse) silty clay.



Operator	T.F.	Date	6.8.92	Approved by	For Contractor	Date	For Engineer	Date
Checked by		Date	17.8.92					

FOUNDATION

EAST YORKSHIRE SALT CAVITY

CONTRACT No: 2172

COMPACTION TEST

B.S.1377: 1975: DRY DENSITY/MOISTURE CONTENT RELATIONSHIP TEST 13.

Borehole/Sample No:. TP4/2 .. .. Depth (m):. . 2.00..... . .. Date: .....AUGUST..1992 ....

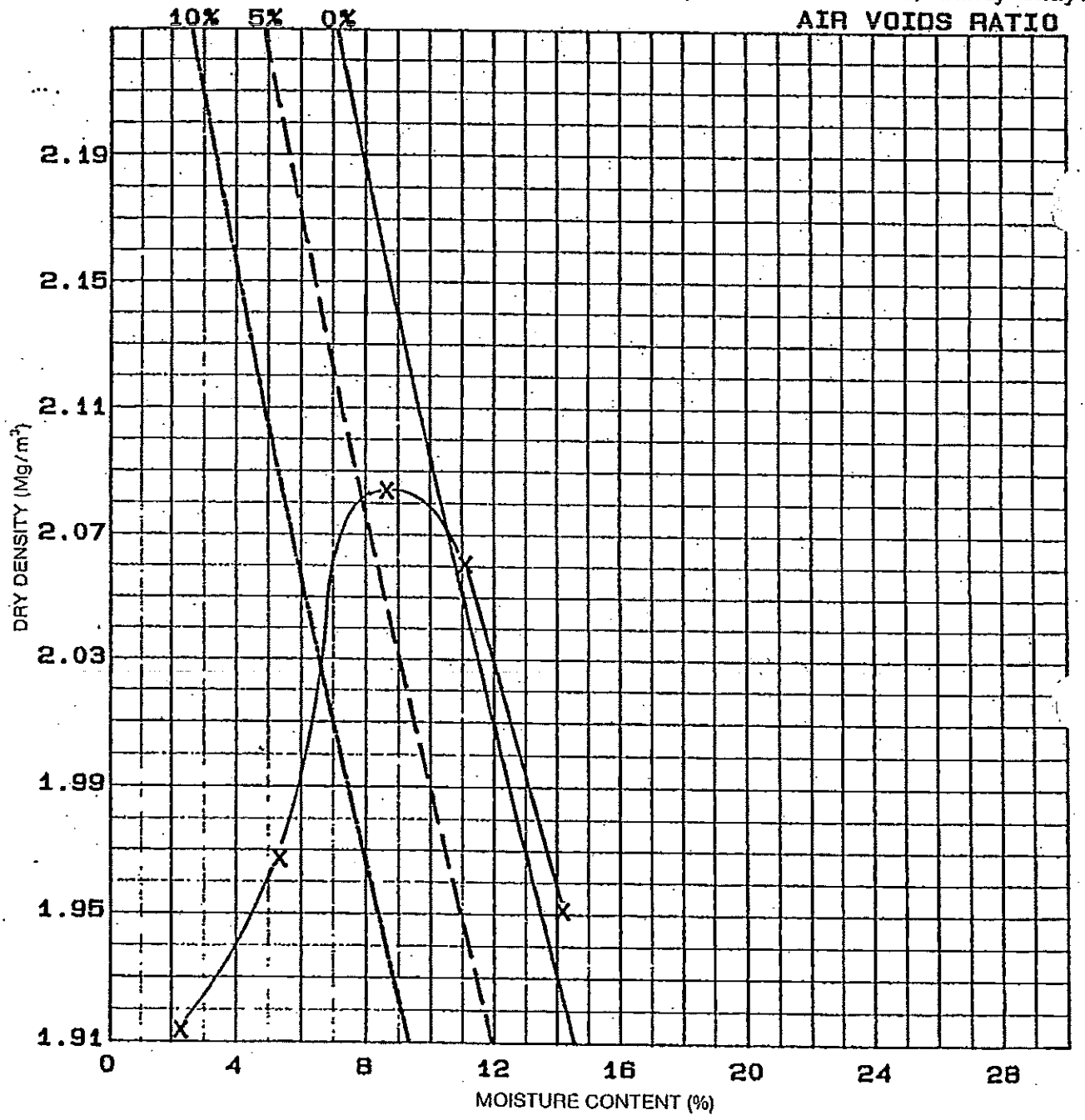
Type of Compaction: ... ... DYNAMIC..4.5..Kg.....

Material Retained on:.....20... ..mm BS Sieve (%) :...15.....Specific Gravity: ....2.65.....(ASSUMED).....

Maximum Dry Density (Mg/m³) : .....2.08.....

Optimum Moisture Content (%) : . .....8.7.....

Description: Brown..fine .to..coarse..GRAVEL..with..much..sandy..(fine..to..coarse)..silty..clay..



Operator	TF	Date	6.8.92	Approved by	For Contractor	Date	For Engineer
Checked by		Date	17.8.92				

FOUNDATION SERVICES

EAST YORKSHIRE SALT CAVITY

(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

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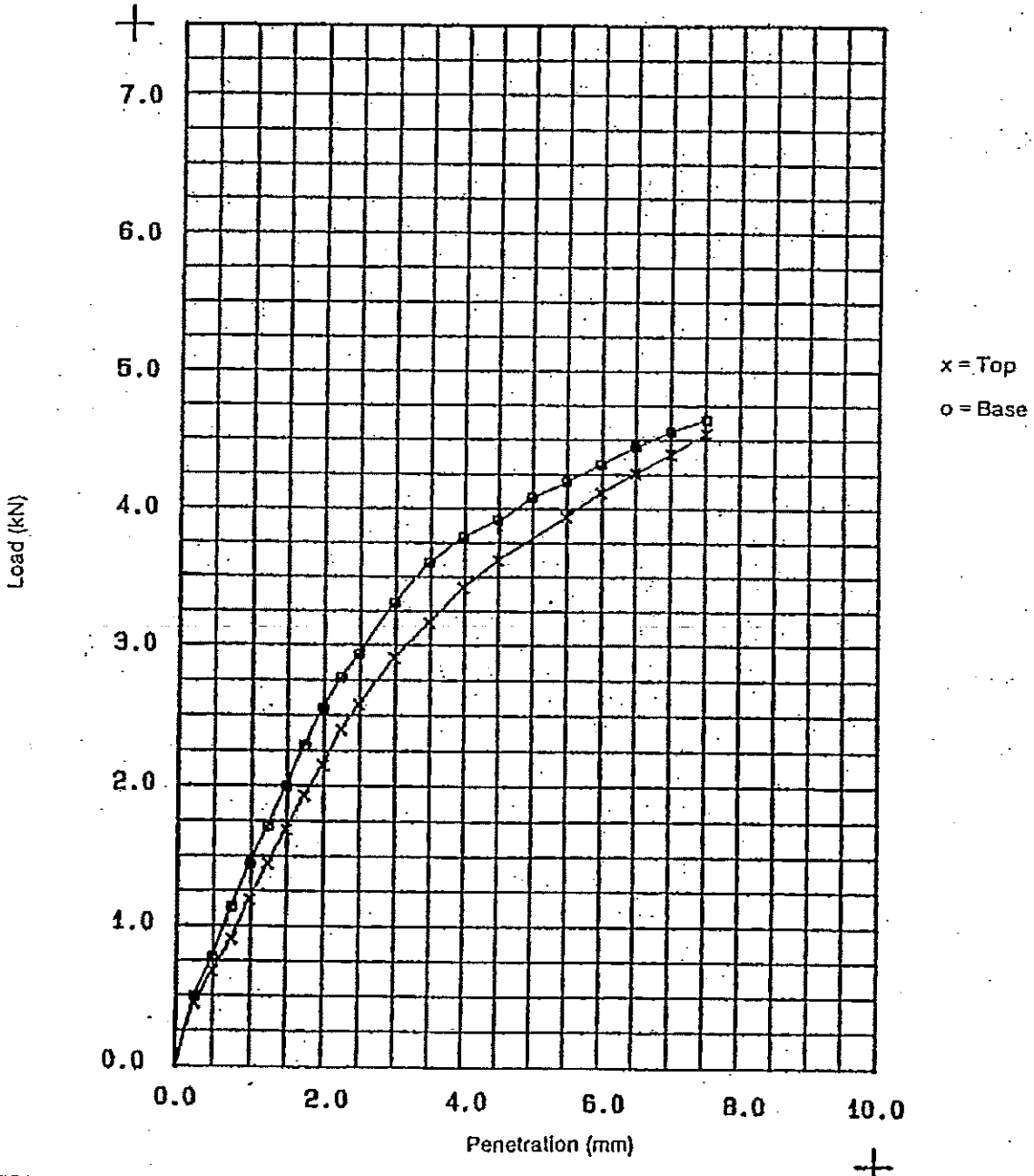
CALIFORNIA BEARING RATIO TEST

B.S. 1377: 1975: TEST 16.

Borehole/Sample No: TP1/1 ... Depth (m): 0.70 ... Date: JULY 1992

Initial Condition		Preparation		Description	
		UNDISTURBED		Dark brown silty fine to medium SAND with a little fine to medium grave	
Bulk Density Mg/m³	1.81	Surcharge kg	8.0	Final Moisture Content %	C.B.R. %
Moisture Content %	6.2	Soaking Time hrs	0.0	Top 7.7	Top 26
Dry Density Mg/m³	1.70	Swelling mm	0.0	Base 7.3	Base 22



Operator		Date	27/1/92	Approved by	For Contractor	Date	For Engineer	Date
Checked by		Date	29.7.92					

FOUNDATION & EXPLORATION SERVICES

EAST YORKSHIRE SALT CAVITY

(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

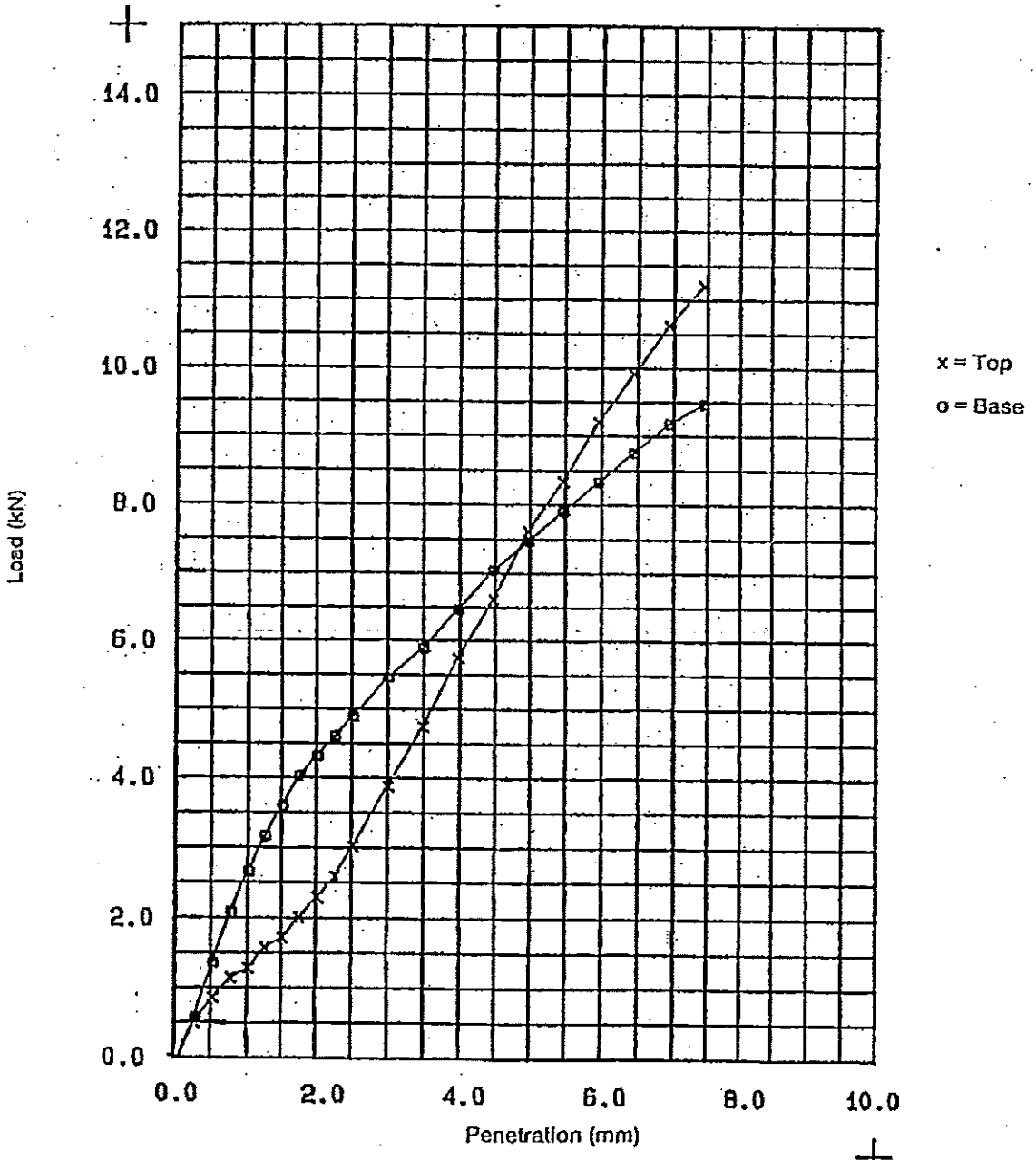
FIGURE:

CALIFORNIA BEARING RATIO TEST

B.S.1377: 1975: TEST 16.

Borehole/Sample No:.... TP2/1 ....Depth (m): ..... 0.80 ..... Date:..... AUGUST 1992 .....

Initial Condition		Preparation		Description	
		DYNAMIC 4.5 Kg		Brown fine to coarse SAND with much fine to coarse gravel and roots.	
Bulk Density Mg/m³	2.04	Surcharge kg	8.0	Final Moisture Content %	C.B.R. %
Moisture Content %	6.1	Soaking Time hrs	0.0	Top 5.9	Top 40
Dry Density Mg/m³	1.92	Swelling mm	0.0	Base 5.8	Base 40



Operator	CL	Date	18.3.92	Approved by	For Contractor	Date	For Engineer
Checked by	[illegible]	Date	18.3.92				

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EAST YORKSHIRE SALT CAVITY

(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

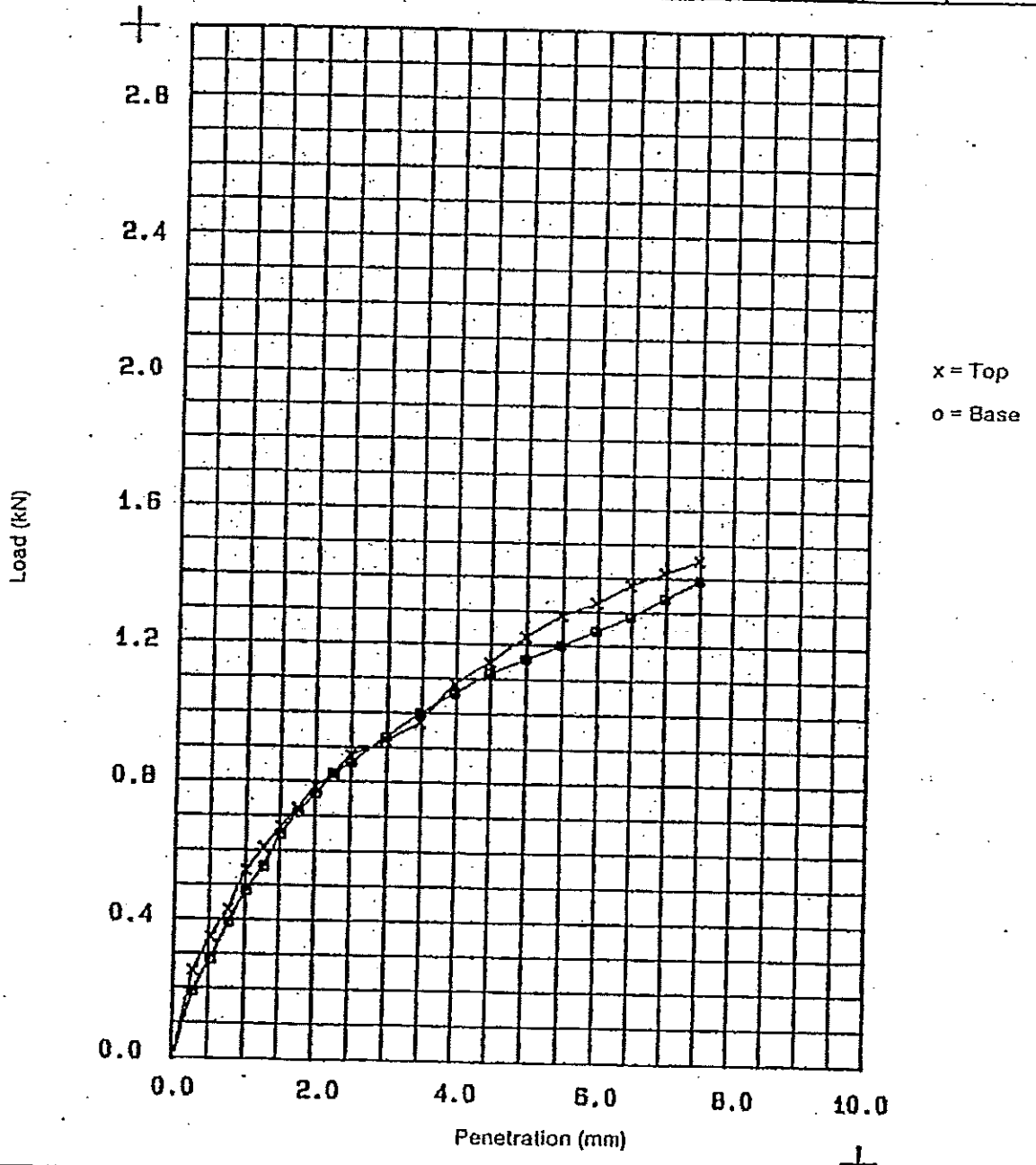
FIGURE: 22

CALIFORNIA BEARING RATIO TEST

B.S.1377: 1975: TEST 16.

Borehole/Sample No: TP3/1 ... Depth (m): 0.70 ... Date: JULY 1992

Initial Condition		Preparation		Description
		UNDISTURBED		Light brown sandy (fine to coarse) silty CLAY with a little fine to medium grave
Bulk Density Mg/m³	1.69	Surcharge kg	8.0	Final Moisture Content % / C.B.R. %
Moisture Content %	17	Soaking Time hrs	0.0	Top 16 / Top 7
Dry Density Mg/m³	1.44	Swelling mm	0.0	Base 19 / Base 6



Operator		Date	27/7/92	Approved by	For Contractor	Date	For Engineer	Date
Checked by		Date	29.7.92					

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EAST YORKSHIRE SALT CAVITY
(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

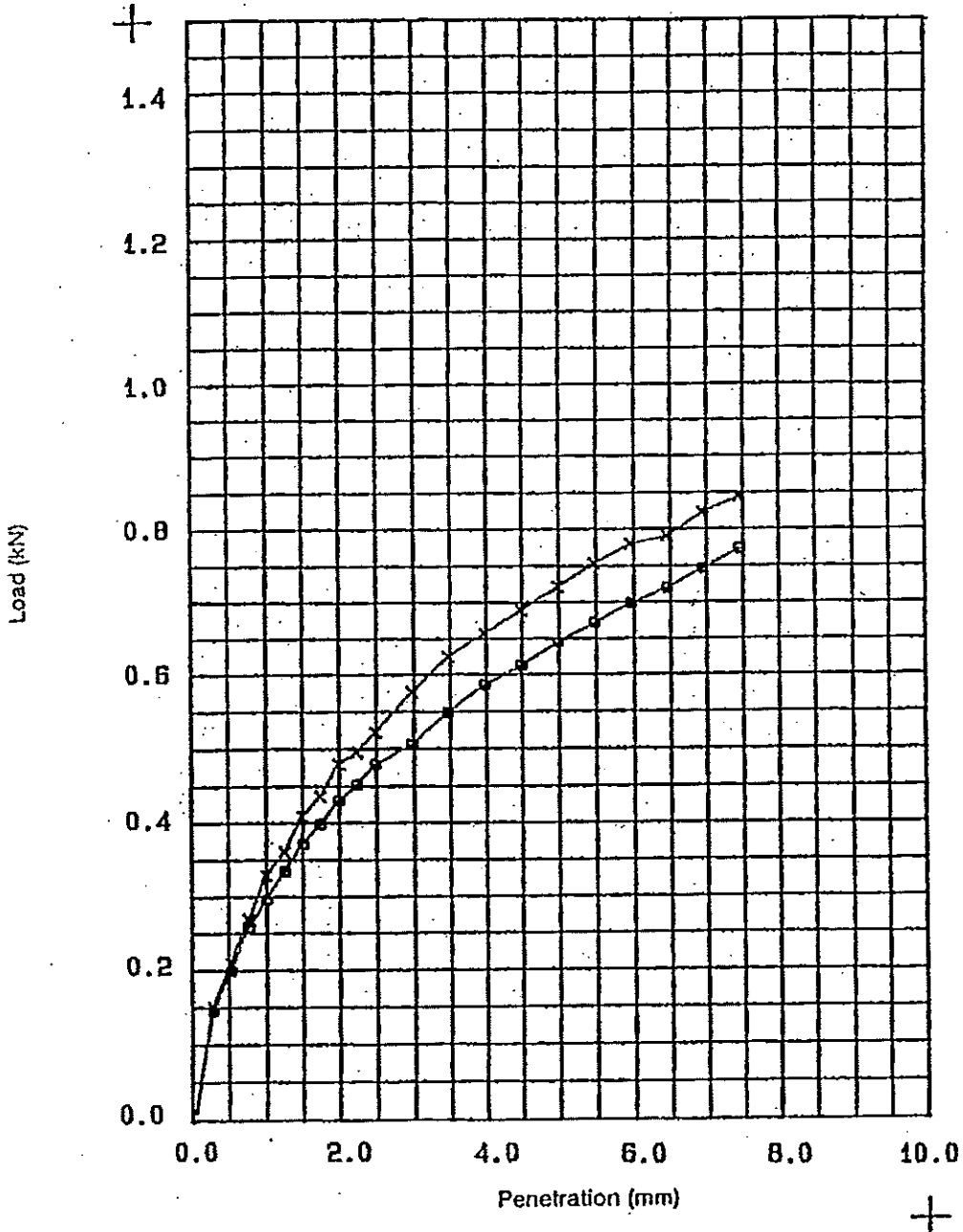
FIGURE: 23

CALIFORNIA BEARING RATIO TEST

B.S.1377: 1975: TEST 16.

Borehole/Sample No: ... TP11/1.... ...Depth (m): .... 0.70 ..... Date: .....JULY 1992.....

Initial Condition		Preparation		Description	
		UNDISTURBED		Brown silty CLAY with a litt fine to medium gravel.	
Bulk Density Mg/m³	2.03	Surcharge kg	8.0	Final Moisture Content %	C.B.R. %
Moisture Content %	24	Soaking Time hrs	0.0	Top 23	Top 4
Dry Density Mg/m³	1.63	Swelling mm	0.0	Base 24	Base 4



Operator	CL	Date	27/7/92	Approved by	For Contractor	Date	For Engineer
Checked by		Date	29.7.92				

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EAST YORKSHIRE SALT CAVITY
(PROVISIONAL SOILS INVESTIGATION)

CONTRACT No: 2172

FIGURE: 24

SUMMARY OF CHEMICAL ANALYSES

B.S. 1377 : Part 3 : 1990

Trial Pit Sample No	Type of Sample	Depth m	Organic Content * Test 3	Loss on Ignition * Test 4	Sulphate Content as SO_3 (as SO_4) Test 5.5			Carbonate Content (as CO_2) * Test 6.3	Chloride Content (as Cl)		pH Value Test 9 ‡	Remarks
					Soil *	2 : 1 Water : Soil Extract, g/l	Groundwater g/l		Soil * Test 7.2/7.3 †	Groundwater g/l Test 7.2		
TP6/4	D	1.00			0.01 (0.01)						8.1	
TP9/4	D	1.00			0.01 (0.01)						8.1	

NOTES: D - Disturbed Sample; B - Bulk Disturbed Sample; U - Undisturbed Sample; † Delete as applicable
‡ In house method based on BS Test 9; * Result given in % by Dry Mass

FOUNDATION EXPLORATION

Compiled by	Date	Checked by	Date	Approved by	For Contractor	Date	For Engineer	Date

CONTRACT No: 2172

KEY TO SITE PLANS AND CROSS SECTIONS

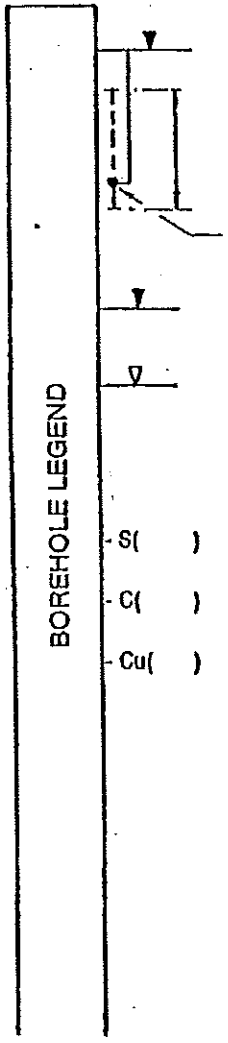
A ⊢—⊣ A Denotes line of section

Denotes borehole position

Denotes trial pit position

For explanation of symbols and abbreviations see 'Key to Borehole and Trial Pit Records' Sheets 1 & 3.

Borehole No.



Denotes highest recorded groundwater level in piezometer or standpipe

Denotes length of response zone

Denotes tip depth

Denotes highest recorded water level in borehole

Denotes groundwater strike

S( ) Denotes Standard Penetration Test 'N' Value using split spoon

C( ) Denotes Standard Penetration Test 'N' Value using solid 60° cone

Cu( ) Denotes Undrained Cohesion in kN/m²

All strata boundaries shown on the site plans and sections are conjectural unless noted otherwise.