

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 1 of 18

230633

Barkham Solar Farm

On behalf of: Bouygues E&S Infrastructure UK Limited
P02



Survey Report			
Barkham Solar Farm		Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey		Version: P02	Page 2 of 18

	Originated by	Checked by	Reviewed by
Original	M. Peter	G. Kanyok	K. Dorman
Approved by	E. Hocking	As Project Manager, I confirm that the below document(s) have been subjected to Catsurveys' Check and Review procedure and that I approve them for issue	
Date	21/02/2024		

This report should be read in conjunction with:

PAS 128:2014 'Specification for underground utility detection, verification and location.'
TSA Guidance Note - The Essential Guide to Utility Surveys
HSG 47 - Avoiding Dangers from Underground Services
Project drawing(s)

Catsurveys Ltd

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Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 3 of 18

Table of Contents

1	Preambles	4
1.1	Task team	4
1.2	Risk Assessments / Method Statements and Safety	5
1.3	Equipment Information	5
2	Survey Scope	6
2.1	Survey Area	7
2.2	Desktop Utility Records Search (DURS)	8
3	Site Specific Observations	8
4	Survey Results	9
4.1	Results Summary	9
5	UWB-GPR	12
5.1	Survey Acquisition Settings	12
5.2	Site Specific Observations	12
5.3	UWB-GPR Coverage	12
5.4	Dataset Examples	13
5.5	Conclusion / Recommendations	15
6	Additional Information	16
6.1	What is Utility Detection and Mapping?	16
6.2	What is PAS 128?	17
6.3	Benefits of a Utility Detection Survey (Survey Type B)	17
6.4	Limitations of Current Technology	17
7	Accuracy Compliance	17
7.1	General	17
7.2	Examples of Mains and / or Services that can be detected	18
7.3	Advisory Note	18
7.4	Calibration Procedures and Records	18
7.5	Horizontal and Vertical Accuracy	18

Table of Figures

Figure 1-	Underground Utility Detection and Topographical Survey	7
Figure 2 -	GPR Coverage achieved.	12
Figure 3 -	Hyperbola detected in b scan view (vertical cross section).	13
Figure 4 -	Timeslice view (horizontal cross section) of suspected utility duct.	13
Figure 5 -	Hyperbola detected in b scan view (vertical cross section).	14
Figure 6 -	Timeslice view (horizontal cross section) of suspected utility duct.	14

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 4 of 18

1 Preambles

1.1 Task team

Project team	Position
E. Hocking	Project Manager
F. Arenas	Senior Land Surveyor
N. Marrow	Senior Utility Surveyor
M. Wyborn	Assistant Utility Surveyor
M. Rydqvist	GPR Surveyor
S. McDonagh	Assistant GPR Surveyor
T. Horvath	Operations Manager
G. Kanyok	Project Owner
K. Dorman	CAD Specialist
M. Peter	CAD Technician

Survey Date	05.02.2024. UWB-GPR Survey 31.01.2024.
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Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 5 of 18

1.2 Risk Assessments / Method Statements and Safety

Prior to attending site, associated risk assessments and method statements were provided to the client and briefed to all survey staff attending works. A point of work risk assessment would have also been completed daily for the works undertaken to allow changes to be recorded dynamically which is our standard practice and are available on request.

All survey staff attending site are provided with suitable and sufficient PPE for the works undertaken or alternatively specifically advised by our client. Highways liveried vehicles and fully trained personnel in the tasks they are required to undertake with suitable supervisory capacity is mandatory. Where required, inductions and other client specific training will have been attended.

1.3 Equipment Information

All operational equipment is calibrated in accordance with the specification and manufacturers certificates of conformity. Catsurveys Ltd is accredited by the BSI to BS EN ISO 9001.

Equipment	Manufacturer	Model	Operator
Electromagnetic Locator	Radiodetection	RD8100	N.M.
Genny	Radiodetection	TX-10	N.M.
Ultra-Wide Band Ground Penetrating Radar	3D Radar DXG	1820 - CW	M. R.
Total Station	Leica	TS16	F.A.
GPS	Leica	GS18 I	F.A., M.R.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 6 of 18

2 Survey Scope

To carry out a topographical survey, non-intrusive underground utility survey using Electro Magnetic Location (EML) and Ground Penetrating Radar (GPR) within the survey boundary.

3. SPECIFICATIONS / STANDARDS			
Topographical:	CATSURVEYS	Utility:	CATSURVEYS
Geotechnical:	N/A	Level(s) Of Detail (LOD):	LOD 0
Composite:	N/A	Other:	N/A
4. SPECIAL REQUIREMENTS			
Site Induction Required:	NO	SAP Required:	NO
Out of Hours Working Required:	NO	Pre-site medical/Fit for work required:	NO
8. UTILITY SURVEY INFORMATION			
PAS Detection Method:	M3P	PAS Quality Level Aim:	B1P
EML:	YES	GPR:	YES
MGPR:	YES	CCTV:	YES
MH Cards required:	N/A	MH Card type:	N/A
Mains:	YES	Services to properties:	NO
Drainage survey method:	SONDE	Services to properties (drainage):	NO
Surface Water Sonde:	YES	Services to signs and streetlights:	YES
Foul/Combined Water Sonde:	YES	Confined Space Entry:	NO
Record No. of utilities in ducts:	NO	Permitted to use spray-paint on site:	YES
9. TOPOGRAPHICAL SURVEY INFORMATION			
Topo detail level required:	Catsurveys Full Topo – Option 1 Accuracy		
Station points provided:	NO	Soft detail accuracy:	
Above ground utilities:	YES	Hard detail accuracy:	
Coordinate system:	OSBG36	Transformation details provided:	NO
Calculation report required:	NO	Levelling Required:	
GPS-Post Process:	NO	Station Point Report required:	

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 7 of 18

2.1 Survey Area



Figure 1- Underground Utility Detection and Topographical Survey

-  Underground Utility Detection and Topographical Survey Area
-  Post-processed GPR Scan Area

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 8 of 18

2.2 Desktop Utility Records Search (DURS)

Utility owners have been identified within the specified survey area. A request has been made for information about the assets from the utility owners. This data has been collated as a basis for this survey and responses from the utility owners are provided within the deliverable.

These drawings have been divided to two groups: affected and unaffected. Affected utility drawings are showing utilities in the vicinity of the survey area. Unaffected utility providers have no known apparatus in the vicinity of the survey area.

Affected utility provider drawings:

- BRITISH TELECOM
- SCOTTISH AND SOUTHERN ELECTRICITY NETWORKS
- SGN
- THAMES WATER - WATER

3 Site Specific Observations

We have completed the survey to the requirements set out in the client provided specification in line with PAS 128 and our own internal Task Method Statements. There were no modifications to the survey boundary at the time of our survey and all areas were accessible without any obstructions or restrictions. Weather conditions did not adversely affect our survey results.

Survey Report		catsurveys	
Barkham Solar Farm		Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey		Version: P02	Page 9 of 18

4 Survey Results

This results section should be read in conjunction with the BSI guidance PAS 128: 2014 Specification for underground utility detection, verification and location. The document will support the methodologies included in this report and support the following quality levels and the associated confidence that can be invested in the detection of each utility.

Quality levels are shown within the survey data for each utility and will range from B1 to B4. Where post processing of GPR data has been requested in the scope, the utilities detected by this method will also include the letter P. For example, B1P.

EML success rates should be higher than GPR in a majority of survey areas. The techniques are very different, especially as EML techniques require cover lifting, probing and direct connection to ascertain detection where GPR only relies on radio waves applied from the surface. EML can also be applied around obstructions where GPR cannot be physically pushed, increasing its coverage. However, the combination of these methods ensure that the existing limitations of each technique are balanced.

In cases where existing records and surveyed information correlate, assumptions have been made that these are detected in the positions shown in the following results. Instances where evidence does not support the positioning of buried assets from surveyed or available records, both the detected and historic records are plotted. This represents an honest view of our findings without unrealistic assumptions being made, whilst avoiding potential hazards from buried utilities.

4.1 Results Summary

The definition for each quality level is aligned with PAS 128 when carrying out a Survey Type B / Detection survey:

All detection B1(P)-B3(P)	907	68.8 %
Total length of underground utilities within survey area (m)	1319	
Area of survey (m ²)	1765	
Average utility density (factor = length/area)	0.75	

PAS128 quality level	Detection accuracy actually achieved		Length of utility detected in each quality level (m)	Percentage of total
	Horizontal 1)	Vertical 2)		
B1	±150 mm or ±15% of detected depth whichever is greater	±15% of detected depth	0	0.0 %
B1P			5	0.4 %
B1-B1P Supporting data	Horizontal and vertical location of the utility detected by multiple geophysical techniques used.			

B2	±250 mm or ±40% of detected depth whichever is greater	±40% of detected depth	616	46.7 %
B2P			467	35.4 %

Survey Report		catsurveys	
Barkham Solar Farm		Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey		Version: P02	Page 10 of 18

B2-B2P Supporting data	Horizontal and vertical location of the utility detected by one geophysical technique used.
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B3	±500 mm	Undefined	25	1.9 %
B3P	±500 mm	Undefined	0	0.0 %
B3-B3P Supporting data	Horizontal location only of the utility detected by one or two geophysical technique(s) used.			

B4	Undefined	Undefined	203	15.4 %
B4 Supporting data	A utility segment which is suspected to exist but has not been detected and is therefore shown as an assumed route.			
B4 (Drainage)	Undefined	Undefined	3	0.2 %
1) Horizontal location is to the centreline of the utility.				
2) Vertical location is to the top of the utility.				

Notes:

The Quality Level “B4” contains the undetectable utilities shown on the provided utility drawings, and in addition, all those utilities, which were identified during the site survey (indicated by surface features or via manhole inspection) were classified the same quality level.

Catsurveys Ltd were required to undertake a utility survey in accordance with the above scope. Using the records made available at the time of the survey to identify all utilities within the survey area the following results have been achieved.

GAS				
ID	Quality Level	Detection		Survey Comments
		EML	GPR	
GAS 1	B4	No	No	The utility was undetectable with direct connection / induction due to its (assumed) material. GPR analysis did not detect the presence of this asset. 'Verification Survey type A' recommended.

Survey Report			
Barkham Solar Farm		Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey		Version: P02	Page 11 of 18

WATER				
ID	Quality Level	Detection		Survey Comments
		EML	GPR	
WTR 1	B4	No	No	Attempted to detect the utility by direct connection, but it was not possible to carry a signal to record its location. GPR analysis did not detect the presence of this asset. 'Verification Survey type A' recommended.

Notes

Measurements on drains and sewers are to the invert levels.

Measurements on cables and metallic pipes are to the centre of the electromagnetic field.

In general, depths detected using GPR will be to the top of the asset. Depths are affected by geophysical considerations but also user interpretation.

As part of our **'Detection Survey type B'**, passive and active EML sweeps were undertaken across the whole survey area at intervals defined by the required detection method. Any linear feature identified in the data whilst on-site shall be either followed to a node where the identity of the utility can be established or, where this is not practical, labelled as "unknown utility".

Where no utility connected to a utility related topographical feature (e.g. manhole, lamp post etc.) the site team carried out a site check without success. Further investigation ("survey type A") may be required.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 12 of 18

5 UWB-GPR

A vehicle-mounted Ground Penetrating Radar system has been used to capture the data required. This is a stepped frequency, continuous wave antenna providing high accuracy, high resolution and high definition of subsurface data.

5.1 Survey Acquisition Settings

The following parameters were employed:

Domain	Frequency
Maximum Frequency	2984.0 MHz
Minimum Frequency	40.0 MHz
Time Window	62 ns
Dwell Time	3.000 us
Sampling Intervals	75mm

5.2 Site Specific Observations

During data collection, weather conditions were observed as overcast and the ground was dry. This provides optimal conditions to capture clear GPR imagery to analyse during the post-processing phase.

Full coverage of the area has been collected on site.

5.3 UWB-GPR Coverage

The following image shows the overall UWB-GPR coverage achieved. The blue area consists of multiple overlapping scans that each have a footprint of 1.5m. By overlapping previous scans, good coverage was achieved with minimal gaps between scans. Each scan is comprised of 75mm x 75mm grids, producing clear, high-resolution imagery to analyse during the post-processing phase.



Figure 2 - GPR Coverage achieved.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 13 of 18

5.4 Dataset Examples

The average visible depth throughout the dataset was 1.5m.
The following images show examples of the post-processing phase.

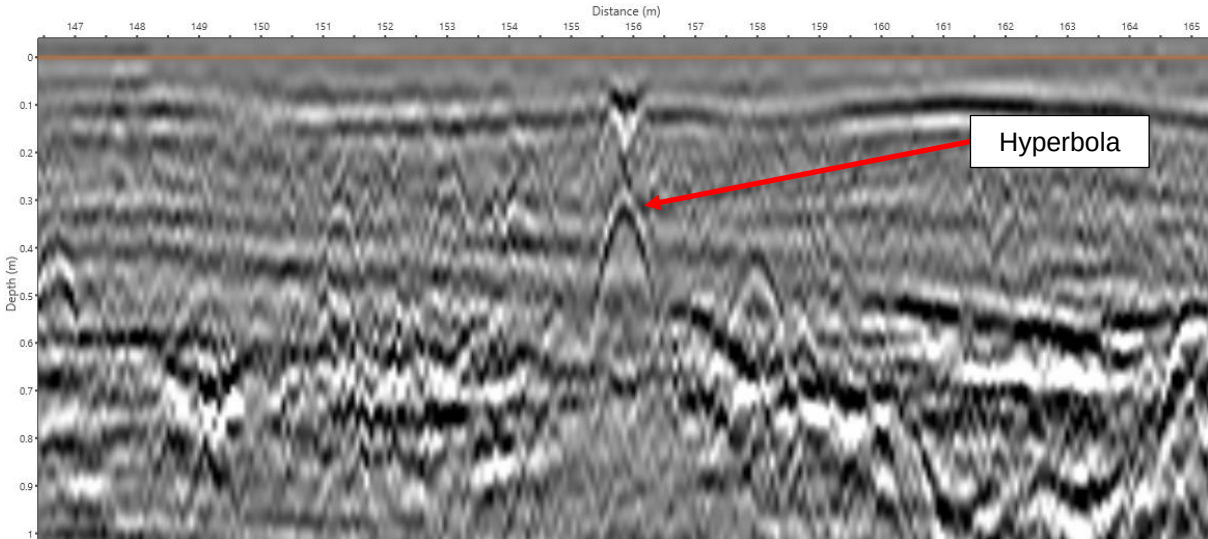


Figure 3 – Hyperbola detected in b scan view (vertical cross section).

A hyperbola is formed by the reflection produced by the linear object while the equipment moves over it, so hyperbolas play a key role in locating objects such as pipes, duct, or other buried objects.

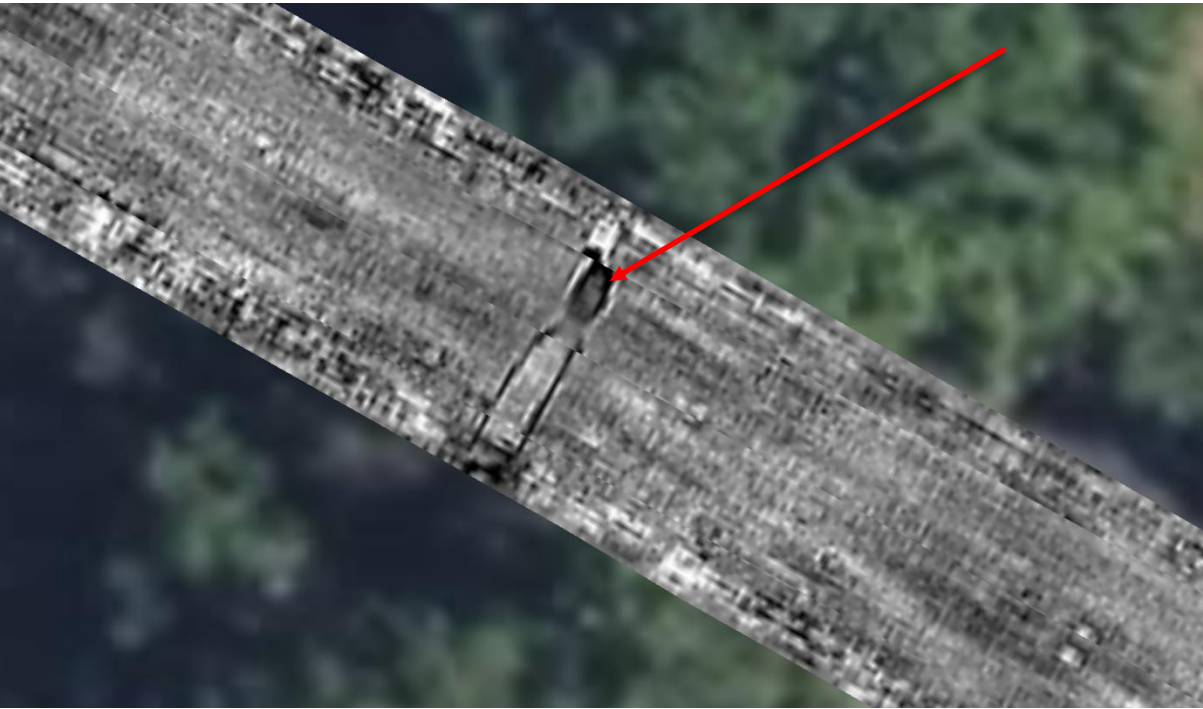


Figure 4 – Timeslice view (horizontal cross section) of suspected utility duct.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 14 of 18

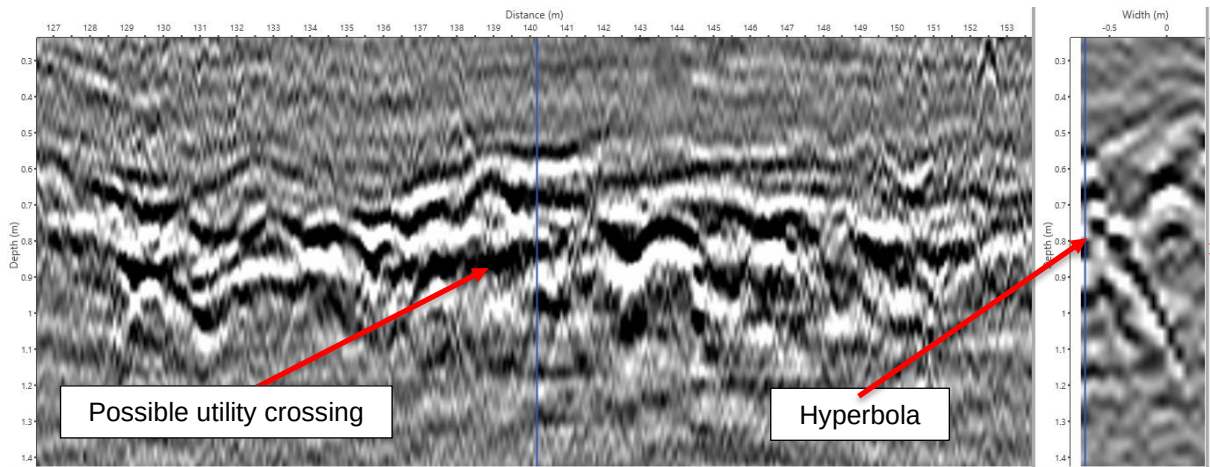


Figure 5 - Hyperbola detected in b scan view (vertical cross section).



Figure 6 - Timeslice view (horizontal cross section) of suspected utility duct.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 15 of 18

5.5 Conclusion / Recommendations

Full GPR coverage was achieved within the survey area and clear high-resolution data was analysed during the post-processing phase.

The GPR data collected is archived internally just in case a different output is desired.

All detected targets have been annotated and included in the provided drawings.

Size/diameter of an object cannot be determined by GPR application.

In general, depths detected using GPR will be on top of the target. Depths are affected geophysical considerations but also by user interpretation.

Caution is always advised when digging.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 16 of 18

6 Additional Information

Please note that the Survey Scope above defines the required and implemented methodology and techniques used on this project. The following information is a brief guide into the survey methods used to undertake a Utility Detection Survey (Survey Type B).

6.1 What is Utility Detection and Mapping?

A utility detection survey provides information on below ground infrastructure such as the position, depth and type of asset. Records are obtained from all asset owners and are used as a basis for the survey and show the infrastructure and its expected position. Each of these assets are searched for using the most appropriate geophysical equipment and the information marked on the surface using temporary spray paint. A majority can be detected using electromagnetic location.

Quite simply, an operative can apply a known frequency to a cable or pipe with metallic composition using a signal generator. This creates an electromagnetic field and is detected using a handheld receiver. The signal can be applied in a variety of ways that may include cover lifting, direct connection or induction methods. The common term for this type of utility detection is EML.

For metallic and non-metallic utilities, Ground Penetrating Radar (GPR) is a common method of detection. An antenna is typically pushed in a trolley configuration with the data viewed on a laptop. The system transmits pulses of high-frequency radio waves into the ground. The transmitted energy is reflected from all buried objects or distinct differences in the earth materials. A reflection known as a radargram can be viewed, from which an operator can distinguish buried assets and mark them on the surface of the ground. Data can also be stored and analysed in an office environment (post-processing) allowing further filtering and production of results. The common term for this type of utility detection is GPR.

GPR can be applied in different ways. In many instances, it is suitable to mark the GPR findings with spray paint on the ground during the survey and record these markings along with the utilities detected using EML techniques. GPR data can also be recorded and processed in an office environment. To acquire this data, either a grid can be marked on the ground for the GPR operator to follow and record these lines or a towable multi-polarised array capable of capturing this grid in one direction using GPS or a Total Station for positioning. The need for recording depends on the site and project needs and the technique used is largely dependent on accessibility and time available.

When using a towed array GPR system, tracking is achieved by using GPS in open areas and total station positioning under tree lined locations or urban corridors. When approaching the GPR survey, coverage and accurate position are the main considerations in terms of data collection. An escort vehicle is used to protect other road users while the GPR antenna is towed within the carriageway and performing the survey. All data is logged and analysed in an office environment using dedicated software.

Many other techniques are used during a Utility Detection Survey to detect utilities. By far the most common techniques are EML and GPR and both should be used to provide the best chance of detecting known and unknown buried assets, this is due to the limitations present in each method. Combining these techniques however, with records and experience can provide invaluable information for the life span of a construction project and the limitations of each detection techniques are balanced.

To preserve the survey and create a map, the detected utility markings and topographic features of the survey area are recorded using geospatial techniques. Total stations, GNSS (Global Navigation Satellite System), Laser scanning and other land surveying principles are used to achieve the result. This information is used to produce drawings in 2D and also 3D models.

Each element of the above can be tailored to meet the project scope.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 17 of 18

6.2 What is PAS 128?

PAS 128:2014: Specification for underground utility detection, verification and location.

The purpose of this document is to set out clear provisions to those engaged in the detection, verification and location of active, abandoned, redundant or unknown utilities. With practitioners using this guideline, the aim is to provide clarity in the service and methods employed, consistency, clear classification of results, standardisation of deliverables and accountability.

By following PAS 128, the accuracy, method used and certainty of the results for each utility detection can be clearly communicated.

Catsurveys recommend that this document is consulted in conjunction with all detection surveys provided, as an aid in understanding the survey results and when considering a utility survey and the level of information required.

PAS 128 is available from the British Standards Institution.

6.3 Benefits of a Utility Detection Survey (Survey Type B)

When implemented early in the design phase of a project, this survey can eliminate many costs and delays due to unexpected encounters with underground utilities.

There are many advantages which are obtained from a well-executed detection survey, including:

- Improvements in the safety and wellbeing of the workforce and public
- Risk Management
- Minimise utility damage and associated costs
- Minimise project delays
- Allow for efficient planning and design
- Avoid unnecessary and abortive work
- Non-intrusive survey method

6.4 Limitations of Current Technology

It should be noted, that the current level of existing technology and methodology cannot be guaranteed to detect all utilities below the ground, particularly small diameter pipes or cables at depth and chamber wall thickness. This is true, even when all aspects of a utility survey are conducted in the optimum manner.

There may be utilities present that due to the limitations in current technology or site related factors, may not be evident at the time of the survey. Non-located utilities may not appear on the final survey drawing. The Client is reminded to ensure observance of HSG47 and best practice when excavating. No liabilities for errors, omissions or exceptions can be accepted by Catsurveys Ltd.

7 Accuracy Compliance

7.1 General

We undertake to survey only for declared utilities shown on asset owners drawings. These are supplied by the client or a DURS is agreed to be provided by Catsurveys at the point of order. We will however, endeavour to locate and track any utilities not featured on record drawings but for technical reasons cannot guarantee to do so. Failure to detect or fully track any declared utilities will be recorded in detail. Any utility that may be undetectable would be plotted on our drawing and annotated appropriately, using quality levels in accordance with PAS 128. The DURS document is valid for 3 months.

Survey Report		
Barkham Solar Farm	Ref: 230633	21/02/2024
Underground Utility Detection and Topographical Survey	Version: P02	Page 18 of 18

The survey is based on Ordnance Survey National Grid OSGB36 by GPS OSTN15 transformation. All levels relate to Ordnance Survey datum Newlyn using GPS geoid model OSGM (15).

7.2 Examples of Mains and / or Services that can be detected

- Water pipes of 38mm and above
- Gas pipes of 38mm and above
- Electric supply cables of 230V to 400kV
- Electric cables to street lighting
- Telecommunication cables
- Foul sewers
- Storm sewers
- Combined sewers

Please note that the survey scope defines, which mains (and services) have been recorded on the current project.

7.3 Advisory Note

Whilst every effort has been made to detect all underground utility assets, no detection technique finds every buried utility. For excavation work, assume utilities are present and act accordingly.

7.4 Calibration Procedures and Records

Calibration of all equipment is carried out in line with manufacturers specification.

A calibration procedure is also undertaken on site prior to survey works commencing. A depth to a utility can be verified from an inspection cover and checked using the EML and GPR for comparison. If the depths do not correlate, these instruments will be deemed as unserviceable and sent to the manufacturers for calibration/ repair. Replacement equipment will be then used.

All GPR survey equipment has a calibration procedure when beginning the survey and each time the system is applied to a different ground make-up.

7.5 Horizontal and Vertical Accuracy

Accuracy of underground utilities can vary depending on the type, diameter and material of the utility, its depth and also local soil conditions. Whilst best practice is implemented, errors may occur in relation to the positions given for buried utilities. In certain cases, this error may be in excess of +/- 20% of the value stated.

Accuracy of topographical features are +/- 0.05m.