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SURVEY REPORT

PROJECT:

MAPPING EXISTING BURIED SERVICES

LOCATION:

BAYFIELDS CHEPSTOW

CLIENT:

BARRATT HOMES

Job Reference TV-6076-2617
June 2017

INTRODUCTION

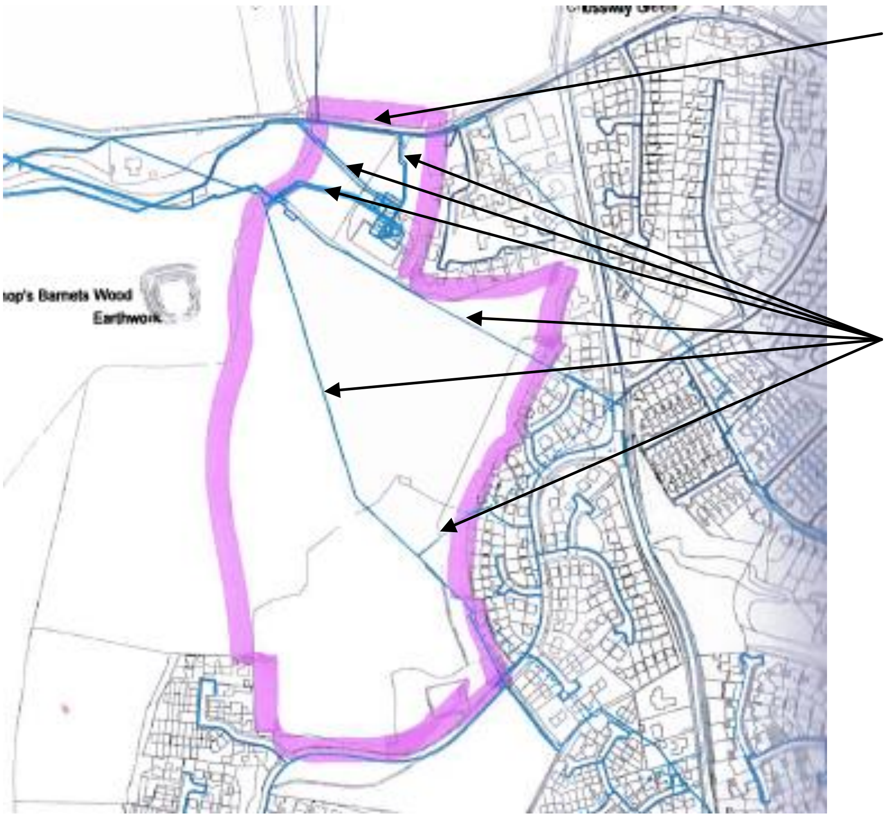
This report describes a non-intrusive subsurface utility survey, carried out on behalf of Barratt Homes at their Bayfields, Chepstow project. The aim of the survey was to locate and identify buried services & drainage prior to the development of the site.

Our survey extents have been indicated on figure 1 below, and include a full utilities survey of the roadway to the north of the site, and a targeted survey of water mains over the southern fields.

It should be noted that areas obstructed with dense vegetation or other impediments may not have been fully investigated.

This report should be read in conjunction with drawing no. TV-6076-2617

Fig. 1 Survey Extents



SURVEY DESCRIPTION

The survey area was walked over and visually inspected for signs or evidence of buried services. Features of interest including trench lines, inspection covers, services furniture, valves etc. were noted and later investigated during our physical survey.

This was followed by the lifting of all accessible inspection covers (within our survey area) and an electromagnetic scan, using both active signals and scanning in passive modes for signals naturally radiated by metallic services.

After the electromagnetic scan was completed, a ground penetrating radar investigation was carried out over accessible areas to target non-metallic services and services not brought to light during the electromagnetic scan.

Physical identification of visible services is in accordance with the National Joint Utilities Group publication: *Identification of Buried Mains and Services*.

Existing Services Information

Record Information

Utilities record drawings were provided to us at the time of our survey and have been listed below. These drawings were referred to throughout our investigations and were valuable in aiding us to identify services that may otherwise have been recorded as an "unknown service".

On occasion, some services shown on existing record drawings may not have been brought to light during the utilities survey. In this instance, the indicative position of the service may have been transposed onto the utilities survey drawing and labelled quality level "D" (QL-D*)* or the lettering TFR (taken from records) incorporated into the CAD layer and line-type of the service. We recommend that any existing record information is referred to in conjunction with our survey results.

Existing record information provided:

Gas:	Wales & West
Water:	Welsh Water
Electricity:	Western Power Distribution
Sewerage:	Welsh Water
British Telecom:	-
Other Communications:	-
Other:	-

Electromagnetic Survey / Radio Frequency Location

Electromagnetic locators were used to trace signals radiated by metallic buried services across the site; these signals fall into two main categories:

1. “Passive signals” found at a frequency of 50-60Hz and 19.6 KHz that are produced by the alternating current of electrical apparatus and by radio transmissions respectively. These signals penetrate the ground and are carried and re-radiated by metallic conductors. These re-radiated signals emitted by buried services may be detected and traced on the surface using electro-magnetic locators.

2. “Active Signals” produced by our own signal generators and transmitting sondes. These signals can be applied to buried services in a variety of ways, and are then traced on the surface with signal detectors to provide an accurate location. The main methods used to apply these active signals to buried apparatus are:

A – Direct Connection

The output a.c. voltage from the signal generator is connected directly to the pipe or cable at an access point such as a valve, meter or cable armouring, and the circuit is completed by a connection to an earth stake or other ground connection point. This method generally produces the best results and is used whenever possible.

B – Induction

The rectangular coil in a signal transmitter fed with the output a.c. voltage sets up a magnetic field through the coil, returning through the earth below. A conductor (buried service) lying parallel to the coil is linked by this field, and therefore, has a voltage induced into it. This technique is used both to trace services found by a passive scan and also to apply a signal to a service when neither direct connection nor clamping is possible.

C – Clamping

Clamping uses the induction principle to give a similar result to direct connection, but without the need for electrical contact to the line (ideally suited to tracing cables found in inspection chambers). The output from the signal transmitter is effectively coupled to a particular line by clamping round it with a split magnetic core which carries a primary winding magnetizing the core with the a.c. signal. The line becomes the secondary of a transformer, and will carry a strong signal, provided that it has good coupling to ground on each side.

The scanning equipment used was *Radio-Detection's RD 8000* precision locators and *RD 8000* transmitters, and accessories. A wide range of frequencies were available to suit all target types.

Accessible inspection covers were lifted, and where appropriate, active signals were used to trace services found within.

Digital photographs of chambers have been taken and are included in this report and stored on the survey CD. Inspection chambers have been numbered to allow for easy reference to the accompanying survey drawing and photo-file.

Data gathered from inspection chambers containing gas and water systems includes the pipework position, identification, depths to top of pipework, pipe sizes, pipe material and apparatus function (stop valve, hydrant, meter, wash-out etc.)

Data gathered from inspection chambers containing cables includes the duct/cable position, identification and depth to top of duct/cable. Where multiple ducts are found, the number of ducts has been detailed and the depth to the top of the shallowest duct and bottom of deepest duct has been recorded at each face.

Digital endoscopy may have been utilised to investigate the nature of chambers with limited accessibility e.g. where a broken cover prevents the cover from being fully lifted.

All detail and measurements have been gauged from the surface and should not be considered as being absolute.

Fig. 2 Electromagnetic Scanning

Drainage Survey

Where possible, manhole covers, gulleys etc. were lifted and drainage routes and connections have been established either acoustically, with drain tracing dye, by passing a signal transmitting sonde along the run or by using ground radar.

Drainage detail includes the recording of pipework position/connectivity, pipe sizes, pipe material, nature, and direction of flow of all evident drainage. The invert level of the main channel exiting manholes has been recorded next to each chamber. Notes may also have been included to draw attention to chambers or drainage in poor condition, root ingress, heavy silting, blockages etc.

Drainage invert depths have been measured from the surface using Laser EDM. All detail and measurements have been gauged from the surface whilst the system was operational and in flow and should not be considered as being absolute.

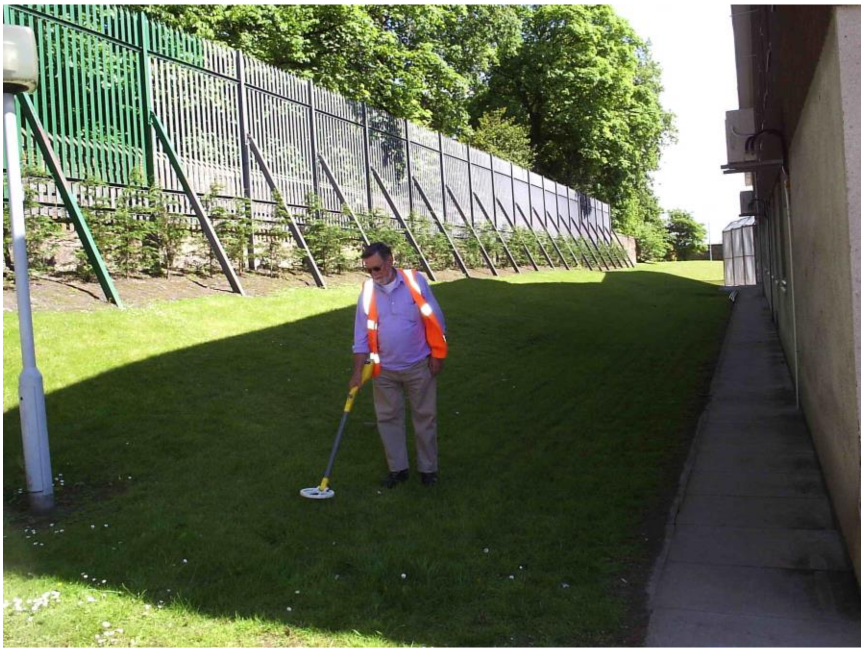
Digital endoscopy may have been utilised to investigate the nature of chambers with limited accessibility e.g. where a broken cover prevents the cover from being fully lifted.

Aside from the manhole immediately opposite the site entrance (MH1) the manholes within the carriageway were deemed too dangerous to lift without the protection of traffic management/lane closures.

Buried Metal Survey

Areas where lost or buried inspection covers were suspected to lie have been searched using a pulse induction metal detector. No such covers were suspected or found during this survey.

Fig. 3 Buried Metal Scanning



Ground Penetrating Radar Background Information

Survey Description

A *Sensors & Software* radar system with a shielded 500MHz antenna (bandwidth 250 – 750MHz) was used in an on-site locating capacity to search the survey area for signal anomalies. Anomalies forming linear features were marked on site and added to the survey drawing.

Our GPR survey of buried services has been based on a combined techniques approach where:

A) Known or suspected services are targeted, using perpendicular transects along their suspected route. Services brought to light during this targeted survey are traced using phase “C”.

B) Once all known or suspected utilities have been targeted and traced, an on site interpretation of sectional GPR data, based on an orthogonal grid over the survey area is carried out. Any linear features brought to light (and thought to be associated with buried utilities) are traced through the survey area using phase “C”. On completion of each trace, the orthogonal survey grid is resumed.

C) Buried services brought to light using GPR (whether during “A” or “B”) are traced through the survey area, by making many short and closely spaced contiguous passes over the target at the perpendicular; enabling the surveyor the best potentiality of following and successfully mapping the service route.

Background

GPR utilises high frequency radio waves to probe the subsurface without disturbing the ground surface. Radar pulses are transmitted downward from an antenna and are reflected from boundaries of contrasting dielectric and geo-electrical properties. When these pulses encounter an interface of materials having different properties, a portion of the energy is reflected back to the surface where it is detected by a receiver antenna and displayed in section for on-site interpretation.

Constraints

The resolution and exploration depth of the radar signal will be reduced by the presence of both conductive material (such as clay-rich soil or saline water) as well as irregular nature of the subsurface (such as backfill material, rocks and rebar). Target detect-ability depends upon a dielectric contrast between the subsurface target and the surrounding material. A relatively smooth surface is necessary in order to wheel the antenna in a continuous line.

A Sample cross section of radar data from the survey has been included in the results and discussion as fig. 7

Radar Features

A description of the typical radar features are given below:

Reflection event: A laterally continuous interface between materials of contrasting electrical properties (controlled largely by composition and moisture content of the material). Examples of reflecting surfaces are soil horizons, soil-rock interfaces, water tables, and solid metallic or non- metallic objects, changes in backfill etc.

Diffraction: A diffraction hyperbolae curve usually indicates a "point" source, such as a void, rock, buried service or an edge feature (e.g. foundation) A zone of small diffraction events can indicate granular/blocky materials or tree roots.

Signal character: Remarks may be made, based on observed changes in the character of the radar signal, such as attenuation, loss of penetration and reverberation.

The main indication of a services presence in radar data are diffraction events that form linear features; in addition to this, phase shift, penetration depth, varying amplitude and reflection events can all help to build a subsurface picture of services and disturbed ground.

Fig. 4 GPR Surveying

Topographic Survey & Mapping

Service routes detected during our investigations have been marked in paint on site. These ground markings have been surveyed using a *Trimble* RTK GNSS system. The Ordnance Survey scale factor has been removed from our results to transform the data to scale factor 1 (level plane) which has then been overlaid onto the client provided topographic survey in dwg format.

The client provided topographic survey has been de-cluttered of superfluous detail, to form a clear presentation platform for the presentation of our results.

The survey has been referenced to the existing topographic survey control stations using *Trimble* GNSS

Presentation

Our digital drawing has been produced as a 2D AutoCAD .dwg file, along with hard copies at 1-250 scale @ A0. Where depth measurements have been taken they have been shown in metres below ground level, next to the relevant service.

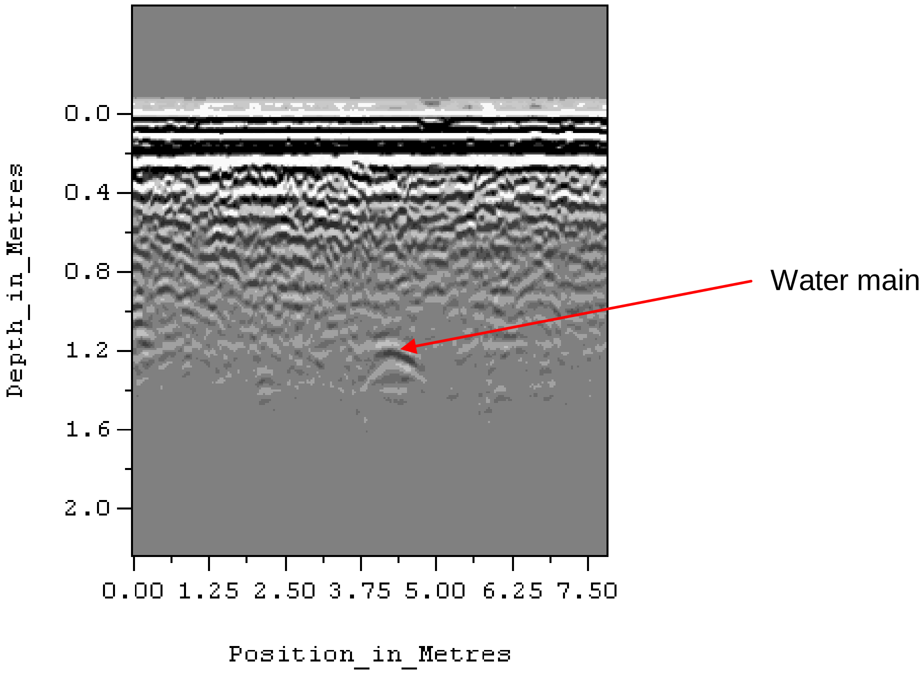
Fig. 5 RTK GNSS Surveying

Fig. 6 EDM Surveying

RESULTS & DISCUSSION

Whilst the time window of the radar was set to allow data to be analysed to a depth of 2.0m with an assumed average material velocity 0.08m/ns, the dielectric properties and conductivity of the subsurface materials have limited the maximum effective penetration depth to approximately 1.3 metres.

Fig. 7 Sample GPR Cross-Section



The locating depth range of our electromagnetic survey is again dependant on ground conditions, target line properties and signal strengths. In good conditions we would expect to detect passive signals to a depth of up to 3 metres and active signals up to 5 metres deep. Drainage up to a depth of 15 metres invert may be located when using a deep sewer sonde.

Although the possible existence of deeper services should not be discounted, it is reasonable to assume that the majority of services would be laid within the depth range of our radio detection and ground penetrating radar survey. It should be noted however, some services may not have been brought to light, have been located only in part or may have been located but not positively identified. We suggest that caution is exercised during excavations.

It should be noted that the survey was conducted without traffic management/lane closures in place; as such the use of GPR and the lifting of covers within the carriageway was limited. There was also a limiting factor, in places, due to site vegetation – see accompanying digital photo file.

PAS 128 Accuracy & Quality Levels

Quality levels as outlined in the document PAS128:2014 *"Specification for Underground Utility Detection, Verification and Location"* have been included on the survey drawing. A guidance table indicating how these levels have been derived is given below.

Fig. 8 PAS 128 Accuracy & Quality Table

Survey Type		Quality level	Post-Processing	PAS 128:2014 derived accuracy		Supporting Data
				Horizontal	Vertical	
D	Desktop utility records search	QL-D	-	Undefined	Undefined	-
C	Site reconnaissance	QL-C	-	Undefined	Undefined	A segment of utility whose location is demonstrated by visual reference to street furniture, topographical features or evidence of previous street works (reinstatement scar)
B	Detection	QL-B4	No	Undefined	Undefined	A utility segment which is suspected to exist but has not been detected and is therefore shown as an assumed route
		QL-B3	No	±500mm	Undefined (no reliable depth measurement possible)	Horizontal location only of the utility detected by one of the geophysical techniques used
		QL-B3P	Yes			
		QL-B2	No	±250mm or ±40% of detected depth whichever is the greater	±40% of detected depth	Horizontal and vertical location of the utility detected by one of the geophysical techniques used.
		QL-B2P	Yes			
		QL-B1	No	±150mm or ±15% of detected depth whichever is the greater	±15% of detected depth	Horizontal and vertical location of the utility detected by multiple geophysical techniques used.
		QL-B1P	Yes			
A	Verification	QL-A	No	±50mm	±25mm	Horizontal and vertical location of the top and/or bottom of the utility. With as much information given as possible.

The PAS 128 table endeavours to establish accuracy levels from methods of detection and supporting data.

It should be noted that the grading set out in the table has limited inclusion for assessing the many variables in quality, distortion or type of detected signals/reflections and ground conditions; or for drawing on the opinion and target specific assessment of the practitioner carrying out the survey. As such, the quality levels recorded may not reflect the considered confidence or quality level that the survey team would assign each locate, or actual accuracies achieved.

We would like to draw particular attention to quality level B3; the PAS 128 guidelines limit the estimated horizontal accuracy to ± 500mm for services where no depth estimation could be established. In our experience, the fact that a depth could not be established has little bearing on the horizontal accuracy of the locate, and ordinarily far better accuracy and confidence levels will be achieved, over those that PAS 128 guidelines allow for a B3 locate.

DISCLAIMER

The transmitters, locators and radar used as part of the utility survey detect signals radiated/reflected by buried services and not the services themselves. The information detailed on the survey drawing is our best interpretation of these signals/data, and although every reasonable effort has been made to achieve accurate and comprehensive results, the survey should never be regarded as 100 percent accurate or complete.

The location and/or identification of a service does not necessarily indicate whether it is live or dead. The fact that a service has not been located or identified does not necessarily imply that it does not exist or is dead.

The performance of the equipment used can only be as good as the signal/ground conditions at the time of the survey and results are not infallible and can be susceptible to distortion.

Terravision personnel have used their best efforts in gathering information and their best judgement in interpreting it but Terravision/Terravision personnel shall not be responsible for any direct, indirect or consequential damages arising from the use of such information.

This report/survey represents an opinionated interpretation of geophysical data/signals and is best used as a guide for follow-up invasive investigation. We recommend that any investigation is carried out in accordance with the Health and Safety Executive's guidelines set out in their publication "Avoiding Danger from Underground Services" (HSG47).

This survey should only be used in accordance with our terms and conditions (available upon request)

Manhole & Inspection Chamber Photos


IC 1


IC 2


IC 3


IC 4


IC 5


IC 6


IC 7


IC 8


IC 9


IC 10


IC 11


IC 12


IC 13


IC 14


MH 1