APEX SURVEYS

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Utility Mapping Report

192 Castle Park, Greenhills

Apex Project Reference:	5330
Date:	12/09/2022
Revision:	1

Apex Surveys
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Introduction

This report will provide a summary of the findings along with the techniques and methodologies used and the constraints of these methodologies. All underground utilities were traced, detected and located on the surface and displayed on background topographical survey mapping.

Company Profile

Apex Surveys is a chartered surveying and mapping company and a leader for surveying services in Ireland. Apex provides a range of industry specific surveys through our Land Surveying, Underground Utility Mapping, BIM Surveying and Drone Services divisions. Our focus is to provide competitively priced surveys that are delivered on time and to the highest possible standard.

Contact Details

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General Project Info

This report should be reviewed with the following drawing:
• *5330 192 Castle Park, Greenhills, TCD ITM15 100 UG 2D.dwg*
• *5330 192 Castle Park, Greenhills, TCD ITM15 100 UG 3D.dwg*
• *5330 192 Castle Park, Greenhills, TCD ITM15 100 UG.pdf*

All works have been completed to the following guidelines and standards:
• *The Essential Guide to Utility Surveying Issue 3, March 2011 published by The Survey Association*
• *Guidelines for the use of GNSS in Land Surveying and mapping published by the RICS*
• *European GPR Association Policy on Utility Detection*

Key Personnel

Field Surveyor	Production Manager	Quality Manager
• BSc (Hons) Geomatics	• BSc (Hons) Geomatics	• BSc (Hons) Geomatics

Project Equipment

Ground Penetrating Radar	Radiodetection	Total Station	Global Positioning System
			
Double or multi frequency shielded Automatic Calibration	multiple locate frequencies 2 induction frequencies 9kHz to < 45kHz: 10W 45kHz to 490kHz: 1W	General Accuracy 5-10 mm	Horizontal Accuracy 10-20 mm

Survey Methodology

General Workflow

1. Request information from utility providers and the site occupants
2. Open and log all manholes, covers and underground fittings
3. Carry out a Cable Avoidance Tool (CAT) survey in different modes (Power, Radio, Genny)
4. Carry out a Ground Penetrating Radar (GPR) Survey
5. Cross reference obtained information with utility provider drawings
6. Insert all obtained information onto the topographic base map
7. Deliver Drawings and Report

Chamber Inspection

Chamber Inspections involve opening all manhole covers within the survey area or within the survey area vicinity which may be of interest. These manholes are individually numbered on the ground, on manhole log sheets and in the topographical survey for identification and clarity.

All depths of the chambers are measured using a levelling staff/ measuring tape and logged on a manhole description sheet along with any other relevant information such as:

- Invert or Top of Duct Level
- Service type (i.e. drainage, cables, empty, etc)
- Pipe/duct diameter
- Pipe/duct make (i.e. iron, PVC, concrete, etc)
- Connecting manhole chambers

Manhole descriptions sheets can be found in appendix A.

Radio-detection

General Principals

Radio-detection uses the principle of electromagnetism to detect underground services. Electromagnetics work under the principle that a current which flows along a conductor emits a magnetic field, which will extend around the conductor in concentric circles. A receiver coil is then utilised to detect the amplitude of the magnetic field, with amplitude varying dependant on the orientation and position of the receiver within the field. By moving the receiver from side to side it is possible to follow the maximum signal response and therefore, the line of the buried service. This method can be used to locate electrical cables by traversing the object area in a grid pattern. Telecom and communication cables can also be traced from chamber to chamber by inducing a current of known frequency onto a conductor with a current generator and then scanning the ground with a receiver set at the same frequency to locate position and depth.

Direct Connection

Where possible the direct connection technique is used to induct a signal into the utility. The signal is then traced on the surface using Radio Detection techniques. The signal is traced along the line of the service and marked on the surface at set intervals, change of direction and change of depth.

Flexi and Sonde

Flexi cable with responder will be fed through the pipe/duct and traced on the surface using a receiver.

Signal Sweeping

Passive power, radio and active sweep techniques are carried out using CAT. The grid involves a diagonal sweep at 5 meter spacing, along an orthogonal bi-directional grid. Depth of utilities can either be obtained through induction or through GPR methodologies.

GPR (Ground Penetrating Radar)

General Principals

GPR works by directing pulses of electromagnetic energy into the ground from a transmitting antenna. The energy travels though the ground where buried objects reflect the energy back to the surface which is received by the GPR's receiving antenna. These returning signals are converted to a GPR section which can be displayed on laptop computer for on-site interpretation or exported for post-processing.

Grid Searching

In low-medium density areas such as green/brown field sites the surface is scanned using an orthogonal grid pattern at 5m intervals to identify potential areas of interest. These AOIs are then targeted for intensive orthogonal follow-up at 0.5m – 1m intervals. Grid lines are saved on the field computed for further interpretation and processing.

Post Processing

Where applicable GPR Grid lines are imported to specialised software for post processing and further analysis.

GPS/Total Station Survey

Detected services are marked on the ground with line marking paint, chalk or mini flags and surveyed with GNSS. This is a continuously operating system with lines surveyed as they are located, or as close to the time of location as possible. In areas inaccessible for GNSS a Total Station is utilized.

Underground Utility Mapping Limitations

The following is a non-exhaustive list of the limitations of utility surveying:

The interpretative nature and the non-intrusive, indirect and non-destructive survey methods must be taken into account when considering the results of the surveys. Therefore Apex Surveys, while using appropriate practice to execute, interpret and present the data, gives no guarantees that all underground utilities and underground structures will be located and mapped. Furthermore, Apex Surveys cannot guarantee the accuracy of the utility depths annotated on the survey drawings.

Apex Survey shall not be liable for any omissions or inaccuracies in the survey which arise due to the limitations of the service. No liability shall attach to Apex Surveys, in any circumstances, howsoever arising, in respect of any consequential loss or damages suffered by the Client.

The following is a non-exhaustive list of the limitations of utility surveys:

The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- **Depth of Utility:** The depth and size of a utility affect the signal response and the degree with which a utility can be located.

  Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
- **Size of Utility:** The smaller the diameter of a utility the more difficult it is to locate. This difficulty increases with depth.
- **Ground Conditions:** The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
- **Utility Congestion:** Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where

similar services run on close proximity, separation may be impossible.

- **Signal Jumping:** Signal from surrounding services may 'jump' to a highly conductive line masking its true identity.
- **Shadowing:** (of deeper utilities by shallower objects) Shallow utilities will mask the existence of deeper utilities where they are in close proximity. Also, high reflective materials close to the surface i.e rebar may hide deeper anomalies.
- **Surface Obstructions:** The GPR system relies on a relatively flat and even surface on which to perform radar passes. If ground obstructions such as vehicles, organic material (long grass, scrub) or undulating ground surface are present then the acquired data will be of lower resolution and in some cases not viable.
- **Loss of signal:** It is not always possible to trace the entire length of each underground service.
- **Connections between manholes:** Connections between manhole chambers are assumed to be straight.
- **Non-metallic objects:** Nonmetallic objects are amongst the most difficult to trace therefore successful tracing of non-metallic pipes/ utilities may be limited.
- **Fiber Optic Cables:** Fiber optic cables may not be possible to locate except where laid with a built in tracer wire or similar conductor system.
- **Defective/ flooded manholes or pipework:** It may not be possible to establish connections between flooded or defective manholes or pipework.
- **Acute bends in pipework:** It may not be possible to trace a pipe past an acute bend.

Record Drawing Information

- Services which have been untraceable are shown from records where possible or available. These lines are annotated as "Taken From Records" or "From Records".
- Existing record information showing underground services is often incomplete and with unknown accuracies therefore it should be regarded as indicative only.
- Where Apex Surveys issue a utility drawing, this should be read in conjunction with all available public or private utility records.
- Apex Surveys endeavor to add relevant Public Utility record information onto the final drawing. However,

we would recommend that direct contact is made with the asset owner or statutory undertaker.

- We shall not be held responsible for the accuracy, or otherwise, of the location of a service, as issued by the utility provider and therefore shown as "Taken for Records" on the drawing.

The following will be excluded from the survey:

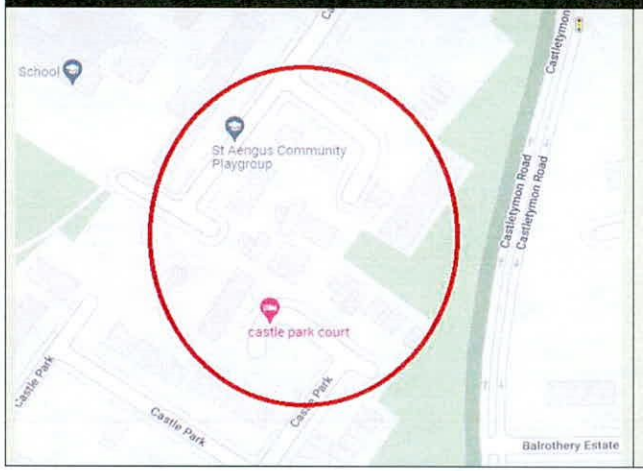
- Location of individual service feeds to properties or buildings as access would be required into each property to apply direct connections to inlet points and this would significantly increase the scope of works, survey cost and also cause possible disruption to occupants.
- Pot ended or disconnected cables or terminated short lengths of pipe.
- Internal building services.
- Small diameter cables less than 20mm diameter or pipes less than 40mm diameter.
- Above ground services unless specifically requested.
- Lifting manholes which require longer than 10 minutes effort using standard heavy duty apparatus.

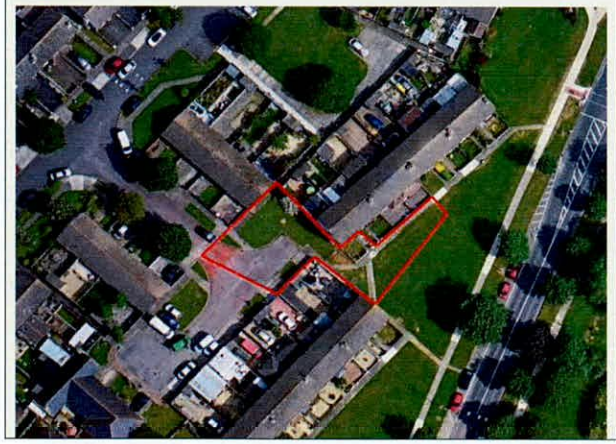
QA Procedures

The following are the QA checks and procedures incorporated into the underground utility survey to either confirm or rule out the presence of an underground utility and thereby reduce the number of anomalies:

- Mark any services radiating from manhole on site and on Drawing
- Note terminations, pipes not accessible for mouse, blocked pipes, metal pipes
- Note terminations, branches weak or lost signals etc on map
- Mark and note all observations
- Do unrecorded Ground Penetrating Radar (GPR) survey on orthogonal bi-directional grid (Note: GPR survey data will be unrecorded and interpreted on site by Surveyors)
- Follow all accessible drains with Cat-Mouse attached to Cobra reel or sewer rods
- Survey in all located underground services
- Draw all information obtained on Drawing and label all underground services
- Flexi reel and sonde are used to confirm pipe connections where the connection isn't obvious. The sonde is traced along the route of the pipe and the direction and depth marked on the surface. When the sonde reaches the next manhole on the line it should be apparent which pipe is connected to which. This rules out any drainage anomalies and provides an accurate picture of the drainage network.
- Check if there is a CAT response to cables in Power or Radio Mode
- Trace all cables and metal pipes with CAT and mark on ground

Survey Location and Extents

Location	Description
	The survey location was situated at 192 Castle Park, Greenhills, Dublin

Survey Extents	Description
	Underground Utilities survey carried out in the area outlined in red as per map shown

Summary of findings

Detected Utilities

Having carried out a thorough underground scan of the survey area it is determined that the following utilities have been detected:	
Broadband Cables **CCTV Cables** **Fibre-Optic Cables** **Lighting Cables** **Power Cables** **Telecom Cables** **Traffic Cables** **Unidentified Cables**	All cabling on site was located through inspection of chambers or using CAT in a passive POWER/RADIO setting. These lines were then inducted, pinpointed and traced using CAT and GENNY. Where possible GPR was used to verify line and depth of the service. All lines were then surveyed accordingly using GPS or Total Station methods to where they ran off site or entered a building or chamber. Where possible these lines were traced to a source in order to determine the amount of ducts and size of ducts omitting the traced signal.
Combined Sewers **Foul Sewers** **Storm Sewers**	All sewers were located through inspection of chambers on site, with the inverts and pipe diameters measured using a staff. Connections between manholes were established through projection of sound from one chamber to another. Where connections were unable to be established a cobra reel and sonde was used in conjunction with a CAT to establish the line and depth of the sewer.
Water Main	All water main on site was located through direct connection using CAT and GENNY wherever possible. Where induction through the pipes was not possible GPR was used to locate the line and depth of the service. These lines were then surveyed accordingly using GPS or Total Station methods to where they ran off site or could no longer be detected. Where the water main was not able to be located record drawings have been drafted. These lines have been annotated as such on the drawing.
Gas	All gas lines on site have been located through GPR methods and surveyed accordingly using GPS or Total Station methods to where they run off site or can no longer be