User Guide: PermaNet+ with Hydrophone. Installation and Setup.

Warning: This manual contains important safety and operating information. Please read, understand, and follow the instructions in the manual.

MAN-148-0007-A January 2022.

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1 INTRODUCTION, BACKGROUND AND SUPPORT OF PRODUCT

Thank you for choosing a HWM device. We trust it will provide you with many years of service.

1.1 SAFETY CONSIDERATIONS

Before continuing, carefully read and follow the information in the "**Safety Warnings and Approvals Information**" document supplied with the product.
This provides general safety information.

IMPORTANT SAFETY WARNING:

This equipment uses a high strength magnet and should not be carried by or be placed in the proximity of anyone with a **heart pacemaker**.

1.2 BACKGROUND

Pipeline leaks are a constant burden to water industries, which can affect the efficiency of the individual company's performance. Leakage loss reduces the amount of water actually being delivered, thus affecting the financial side of the business. The longer the leak is left, the larger the economic, and potentially environmental, consequences. It is therefore more beneficial and safer to detect a leak early and make repairs to the pipes before significant damage to the business is caused.

At HWM, we pride ourselves in designing the best leak detection equipment at an affordable price for the benefit of water companies.

1.3 ABOUT PERMANET+

PermaNET+ is a powerful leak detection system that allows the user to deploy a fleet of data loggers around a water network that are permanently installed to listen for leaking pipes. The data logger units are called PermaNet+ devices.

The logger's highly sensitive Hydrophone is a sensor switches on at night, at a time specified by the user, and takes samples of the noise it hears on the pipes. This is presented as 2 figures, Level and Spread. The level figure represents the sound level that occurs most often during the sample period and the spread is how much the sound varies during this time. A large, consistent Level and small Spread is typical of a leak whereas a small level and large spread is typical of a background noise.

If the logger believes that there may be a leak, then it takes another set of samples after a definable period and compares this to the first. If leaking water noises are suspected, the logger can be set to automatically make a short recording (Typically 10 seconds).

This allows the user to play back the recording to decide for themselves if the recording sounds like a water leak.

The PermaNET+ system will also perform noise analysis and present the data as Histograms that help to visualise the noise into patterns that can be identified as leaks.

The logger sends this data once a day to a central server.

1.4 Documentation and Support of Product

This user-guide covers the following model families:

Model Number(s)	Description
PN/*/*/*	PermaNet+ (Leak detection logger device) +
HYDROPLUSKIT/*	Hydrophone kit.

The user-guide should be read in conjunction with:

MAN-148-0002	Safety Warnings and Approvals Information.
MAN-130-0017	User Guide: IDT (PC version) – Logger User Interface

Retain all documents supplied with the equipment for future reference.

This user-guide provides details of the product operation and instructions on how to install the product.

You should also read the relevant parts of the IDT (PC version) user-guide for guidance on how to confirm settings or modify the set-up your equipment.

To view your data a viewing tool is required; refer to any user-guide or training materials relevant to the tool you will be using (see also sections 7 and 8).

Note: The system periodically has new features and changes released, thus you may observe slight changes from the diagrams and features shown in this manual.

HWM provides support of the logger devices by means of our customer support webpages:

https://www.hwmglobal.com/help-and-downloads/

Should you have any questions that are not covered by this manual or the system's online help, please contact the HWM Technical Support team on +44 (0) 1633 489479, or email cservice@hwm-water.com

1.5 Operating Temperature

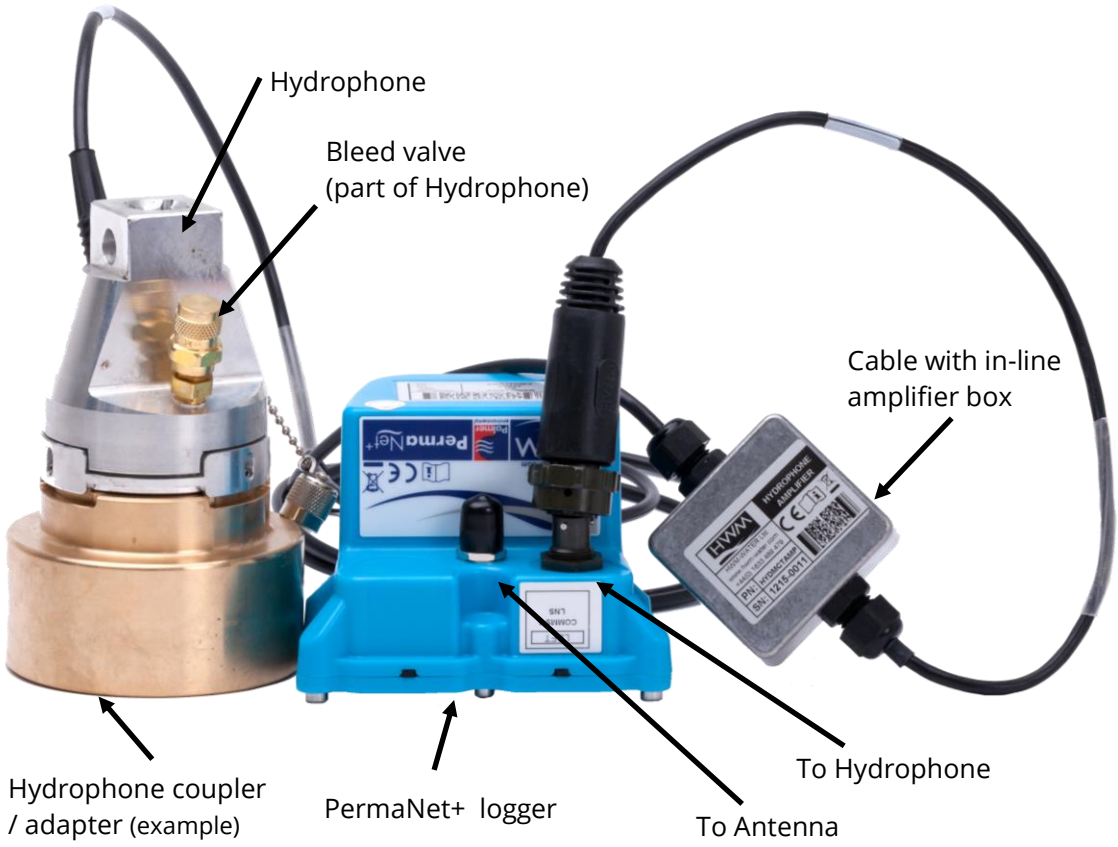
Refer to the PermaNet+ Datasheet or your sales representative for guidance on the storage and operating temperature range of the device. Ensure the unit is within the operating temperature range prior to installation.

1.6 UNPACKING

As you unpack your new PermaNet+ logger and Hydrophone, please confirm that you have the following parts:

- PermaNet+ data logger.
- Cable (with in-line amplifier box) for connecting the Hydrophone to the PermaNet+ logger.
- Hydrophone unit.
- Any couplers / adaptors ordered for adapting the Hydrophone to the water network connection point.
- Antenna (for direct attachment or cabled attachment).
- (Optional) Antenna extension cable.
- (Optional) Antenna mounting bracket / hook.
- (Optional) Magnet tool.
- Safety Warnings and Approvals Information leaflet.

If there are any omissions, please contact our sales team to rectify or supply the missing parts.



Please dispose of your waste packaging responsibly

2 OVERVIEW AND PREPARATION FOR USE

2.1 PERMANET+ LOGGER – DEVICE OVERVIEW

Note: The PermaNet+ loggers have standard settings for operation programmed into them prior to shipping from the factory, with some variations according to customer requirements.

The PermaNet+ product family includes models with an interface for the HWM Hydrophone unit. They are (when the antenna and sensor are attached) of a waterproof construction, being designed to be permanently installed around a water network, listening for leaking pipes. The devices accomplish this by means of a specialised microphone (the Hydrophone) that can detect the sounds that occur within a pressurised network; In particular, they are listening for sounds emitted from a pipe leak. A micro-controller, built into the unit, measures the noise level once per day and performs a statistical analysis to generate data for a "noise histogram". A leak-state judgement is made, along with two additional results called "level" and "spread". The results are saved in memory, for upload at a later time.

2.2 MEASUREMENT DATA TYPES

The saved data could be in the form of:

- A "noise histogram".
  This provides a detailed indication of how consistent the noise measurement is and can be used for more advanced analysis. Histograms can also help to visualise the noise into patterns that can be identified as leaks.
- A Level / Spread indication.
  These two figures are a numeric summary of the noise histogram. The "Level" figure represents the sound level that occurs most often during the sample period. The "Spread" figure is how much the sound level varies during this time. (A large consistent Level and small Spread is typical of a leak, whereas a small Level and large Spread is typical of background noise within a pipe).
- A "leak / no leak" status.
  This gives a simple indication of whether results indicate a probable leak.
- Sound recording files.

2.3 BATTERY / LIFETIME

The logger is powered by non-rechargeable Lithium batteries. The logger is designed to minimise the battery use and thus increase the life expectancy of the unit (e.g., the loggers become active when needed; most of the time they are in standby). The battery life is also affected by user-programable settings.

2.4 CELLULAR COMMUNICATIONS AND SIM-CARD

The PermaNet+ logger includes an interface to the cellular communications network, which provides access to the internet. The data stored within the loggers can be sent automatically over internet using the mobile communications network. The normal destination of the data is the HWM DataGate server.

Communication is 2-way between the logger and server, by means of a proprietary protocol using UDP packets sent to the internet using the cellular communications network.

A SIM card is normally fitted within the logger.

2.5 COMMUNICATIONS WITH A LAPTOP COMPUTER

The logger includes a serial communications interface. This enables the user to communicate with the logger during installation and make on-site tests. Communication requires the attachment of a HWM communications cable and also the HWM "IDT (PC version)" software.

2.6 LOGGER OPERATION - REPETITIVE FUNCTIONS

The PermaNet+ is shipped from the factory in a minimally active state, to extend battery life whilst in storage (e.g., no measurements are made or logged). This mode is designed for periods of storage or shipping of the device, with the logger referred to as being in "shipping mode", or "sleeping". Once activated (see section 2.13), the logger no longer sleeps, but begins its repetitive daily tasks. Whenever possible it saves power by putting circuits it does not currently need into a "standby" condition.

The logger will become highly active at the time it is required to make any sound measurements, complete its leak evaluation, and store the results as a set of data within its memory. The logger will then go into standby until the next programmed event.

When it is time to upload the data over the mobile network, the logger switches on its cellular radio circuits and sends its data. Once completed, it puts them back into standby mode.

The logger occasionally checks the communications link to see if a user wishes to communicate with it; If so, it opens the link. This link remains open for communication for approximately 2 minutes, waiting for instructions. If there is no interaction from the user during this time, the logger puts the communications link back into standby. If the user begins using the link, the logger completes any tasks the user gives to it and then keeps the link open for 10 minutes after it was last used.

The logger's primary task is a leak-sensing program, which runs once daily. The Leak-state evaluation program takes place between 2-4am (although it can be changed). Typically, it is made during a time of low water use to reduce the possibility of consumer

water use being incorrectly judged as a leak. During this time, if the logger determines a change of leak-state, it carries out a secondary confirmation evaluation.

If the logger determines that a new leak is likely to be present near-by, it can (if so set) automatically make a sound recording when the new leak is detected. The sound recording is by default 10 seconds in duration.

Note: Making and transmitting sound recordings can use a lot of data and also drain the battery significantly if too many are made. In order to preserve battery life and reduce data costs, the recording system is restricted to 7 recordings a month. If you have a specific requirement for more than this limit, then please contact HWM customer service for assistance.

2.7 SYSTEM OVERVIEW

The loggers form only a part of a functioning PermaNET system. A typical system will comprise of:

- A set of PermaNet+ (with Hydrophone) loggers.
  These are set to evaluate the sounds within a pipe overnight, when water use is minimal, to determine if a leak could be present nearby.
- A Laptop PC (with Microsoft Windows).
  The laptop PC can (with HWM software installed and a suitable comms cable) provide a Graphical User Interface for the user, giving access to set up and test the logger.
- HWM "IDT (PC version)" application software (installed on the PC).
  A software tool (**I**nstallation and **D**iagnostic **T**est) used to check or modify logger setup and to put the logger into various modes in order to test it within an installation.
- A server, set up to receive logger messages and data. The server acts as data warehouse, safety storing the logger data and also providing it to the authorised viewing platform. This is typically the HWM Datagate server.
- A User-account and password for the HWM DataGate system (for administration purposes).
- A User-account and password for the chosen data viewing website (for viewing your data / leak determination results).

Note: The term "DataGate" will be used throughout this manual.
An alternative name may be used by the server in your location.

2.8 DATAGATE

2.8.1 DataGate – Terminology and Summary

This section *introduces the terminology* that is used by DataGate and the IDT…

The destination of PermaNet+ logger data is usually the DataGate system, provided by HWM. DataGate and PermaNETWeb web-pages are the main administration and viewing portals for logger and site data.

An overview of the scheme is summarised here…

PermaNet+ **logger devices** produce several forms of measurement data, each of which can be considered as a data **channel**. The data represents a measurement made by a logger deployed on the pipe network. Access to the pipe network is often available through various chambers that house valves or hydrants, connected to the water pipes. A chamber can be used as an installation **site** for a logger. A site may be one of many in an area of inter-connected pipework (which may be known by various names (e.g., zone, district, suburb, area); some areas of the water network may include a water meter to monitor water use, which DataGate can refer to as a District Metered Area (DMA). Sites in a certain area may therefore be collected together in a group, often referred to as a **DMA**. DMAs, in turn may be collected together in a group, referred to as an **account** (or Zone). Each of these separate entities may be represented on a database, such as one used by the **DataGate** system, which links some of them to a **User** of the system.

Or, put in reverse order…

- **DataGate** contains a database.
- A **User** of Datagate can be linked with an account.
- An **accoun**t can be a group of multiple DMAs.
- Each **DMA** can contain multiple sites.
- Each **site** can have one logger device installed at any given time (or none).
- Each **logger device** can produce multiple **channels** of measurement data.
- The **data** of a channel may consist of multiple samples that are obtained at different times. It is linked to the site on which the logger is deployed.

2.9 LOGGER MEASUREMENT DATA – DESTINATION AND USE

The PermaNet+ loggers and the DataGate system together form a powerful leak detection system. The data produced by each logger is uploaded to DataGate. DataGate links the measurement data of each logger to the correct site.

DataGate web pages are mainly used for administration and setup. PermaNETWeb web pages are mainly used for displaying sites, along with the measurement data provided by the logger. The primary use within PermaNETWeb is to present loggers on a map display, highlighting loggers that show possible pipe leaks.

When available, sound recording files can be used to confirm whether the sound within a pipe does resemble the sound produced by a leak. Additionally, if several sites in the

area have loggers that have produced sound recordings at precisely the same time, the approximate location of the suspect leak can often be found, using a process called Leak Localisation / Correlation.

Note: Always use a ground microphone to confirm a leak location prior to commencing repair works.

2.10 Ways to set the Logger Configuration

The PermaNet+ holds many setting parameters that affect its operation.

Example settings are:

- When to make the Leak detection.
- Whether to automatically make a sound recording of a suspected leak.
- Scheduled measurements (a manually set temporary additional task).
- When to call-in with the data.
- Mobile-network settings (e.g., telephone number, network to use).

The logger settings can be adjusted at various times…

- Initial settings are made within the factory, prior to shipping.
  Default settings are used, plus some settings being customer-defined. These will be suitable for most installations.
- The IDT software gives the user access to adjust some settings. The user has to be near the logger to make the changes over the aerial communications cable.
- After installation, some additional settings can be modified remotely, via the unit receiving commands from the DataGate system.

2.11 IDT – Test of logger within an installation

The user of the IDT software can instruct the logger to do various maintenance tasks, such as communications tests. This is particularly useful when done on-site since communications are affected by the (often below-ground) location of installation, local signal strength of the mobile network and the radio leakage properties of the chamber.

e.g., The IDT app can help by making test calls or show signal levels to find the best position for an antenna.

2.12 Overview of the deployment process

The deployment process depends on the strategy employed by the water company. There are two approaches:

- Deploy each logger to a site, with checks of functionality being made during each installation. This confirms the logger performs OK in its installed position.

- Deploy the loggers to sites without any checks being made (i.e., skip some of the steps listed as optional). A follow-up team is then sent to selected sites to improve those that have communication problems.

Installation consists of several steps…

- Installation sites must be selected. These should have a description and reference number to identify them on DataGate.
- Equipment must be available at the installation site to complete the installation. This will include any adaptors or couplings required to connect between the Hydrophone and the water network valve.
  This will also include an antenna. It is possible that several antenna configurations may need to be tried in order to get a good result. It is useful to have a variety of antenna types to try.
- The installer must activate the logger (using a strong magnet) to take it out of shipping mode.
- The user connects a communications cable between the PC and logger. IDT can be used to read current settings from the logger into the computer memory.
- Prepare the Hydrophone and couplings for connection to the water valve. Ensure they are suitably clean and sterile. Ensure the bleed valve is closed.
- Ensure the valve to which the Hydrophone is being attached is suitably clean and sterile.
- Lubricate the connecting surfaces to ensure they do not become permanently bonded.
- Fit the Hydrophone to the water valve whilst ensuring any health and safety requirements or work practices for undertaking work on pressurised water pipes are followed. Undertake a risk assessment prior to commencing work.
- Connect the Hydrophone to the logger.
- The antenna is connected to the logger. The antenna location within the chamber is then determined (this may need to be adjusted later; it is a trial-and-error process).
- (Optional). The user can adjust some of the settings of the logger.
  Alternatively, leave the logger settings in their factory-set configuration.
- (Optional). The user can (whilst the chamber lid is off) make a Call Test to DataGate to verify internet connectivity settings are OK and that data can be sent.
- The lid of the chamber is closed (unfortunately, this degrades the signal with the mobile phone network), and the power-level received from the mobile network (e.g., CSQ level) is checked. If inadequate, adjustments need to be made to the antenna position, or the type of antenna used, to find the best CSQ level.
- With the lid of the chamber closed (and positions finalised), a further Test Call is made to confirm the logger can send and receive data.

- The PermaNet+ logger goes to into standby until it needs to make leak determination measurements or send in measurement data. Periodically it completes these tasks.
- DataGate must be prepared to receive data from the logger; this is an administration process.

2.13 Logger activation process (for First-time use)

When shipped from the factory, the unit is deactivated. This mode is designed to preserve its battery life whilst being shipped or in long term storage; this is often called "shipping mode".

To use the logger, it must first be *activated*. The equipment will then start running its program for daily leak determination.

On the side of the logger there is a label showing a magnet symbol. A magnetic field sensor is located under this label.

A strong magnet must be constantly held against the coloured dot on the base of the unit (near the magnet label) for **12 seconds** to start the logger.

3 Communicating with the Logger

To communicate with the logger, a PC is required, along with a HWM software utility called "**I**nstallation and **D**iagnostic **T**ool", or more commonly known as IDT (PC version).

Note: There is another version of IDT, the IDT (mobile app version).
The app version of IDT is not compatible with this logger device.

3.1 Installing IDT (PC version)

IDT (PC version) and its user-guide can be downloaded from the HWM Customer Support website, or from the following webpage:

https://www.hwmglobal.com/idt-support/

(Note: The user has to be registered by HWM and have a password to gain access).

Refer to the IDT User-guide for information on how to install and use the tool.

3.2 COMMUNICATING WITH THE PERMANET+ LOGGER

3.2.1 Connecting the comms cable

To communicate with the unit a communications cable is required.

This is a "Y-cable" (3 connectors). (HWM cable part-number: CABA9349/P).

- One connector is for temporary connection of the Hydrophone.
- One connector is for the logger (plugs into the "LNS & Comms" interface).
- One connector is for the PC's USB port.

Once you have installed the IDT, launch it. Then connect the Hydrophone to the PermaNet+ via the communications Y-cable and then to your PC.

Note: There will be a short delay before the PC recognises the connection of the logger. This is normal. If your PC has sound enabled, you will hear a sound when the logger connects.

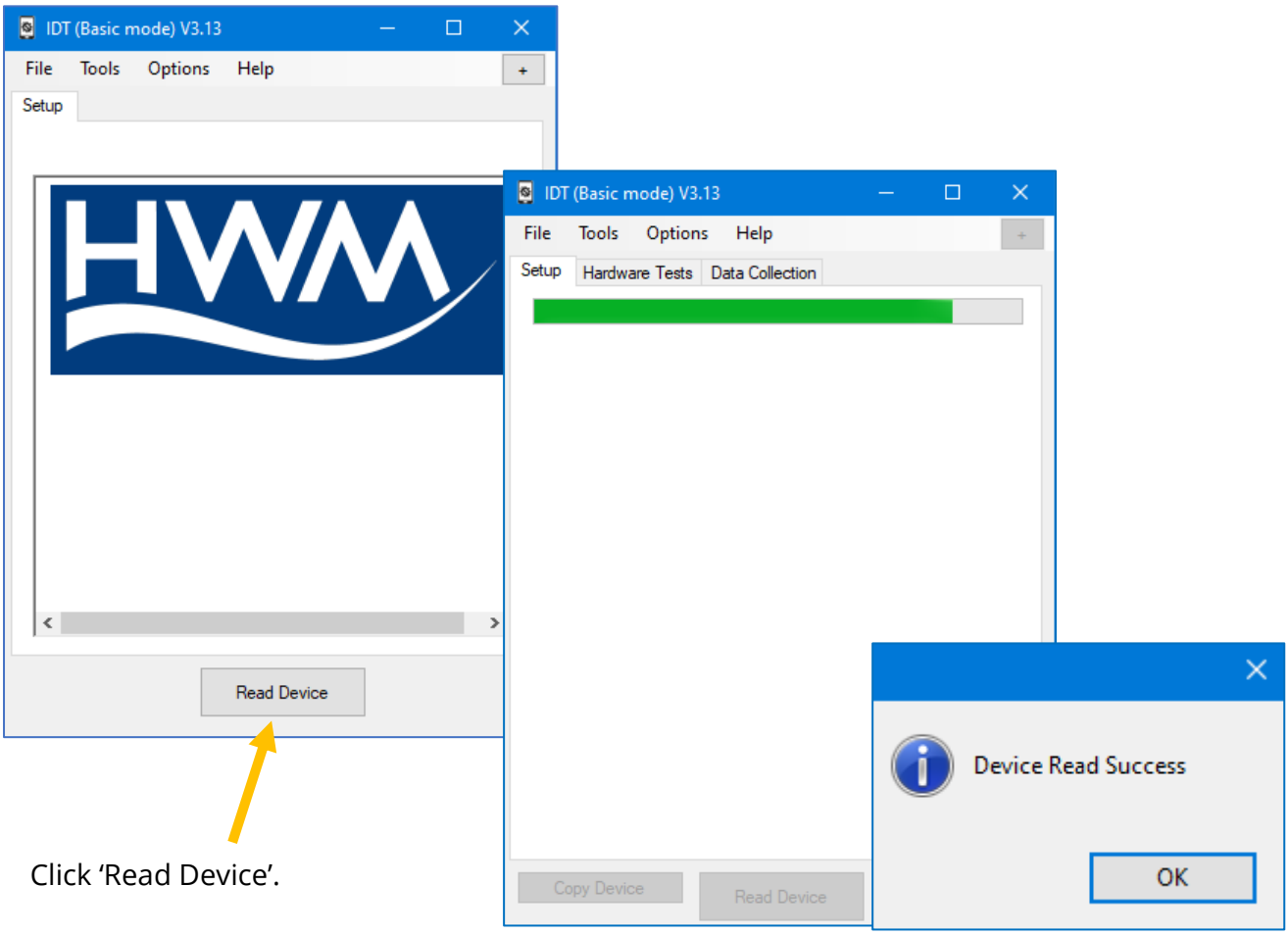
1) Connect the Hydrophone to PermaNet+ via the Y-cable.

2) Connect the Y-cable to a USB port of the PC.

The first time you connect your PermaNet+ to a new USB port, Windows will configure the driver; Wait until this process is completed before proceeding.

The communications circuit is normally on standby, to preserve the unit's battery. Communication remains open for around 600s after it was last used. The link then goes back into standby. If this happens, unplug the USB cable for a few seconds then re-connect it.

3.2.2 Loading Logger settings into IDT

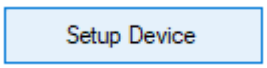


Click 'Read Device'.

A progress bar will show across the top of the page. When completed, an information box will appear stating 'Device Read Success'. Click "OK" to clear the box.

The IDT-PC program has now read a copy of the unit's program (settings) into the "current program" memory area.

The settings can be changed within IDT but note that the unit itself is not updated with any of the program changes unless the user later saves the settings stored in IDT back into the logger by clicking on the "Setup Device" button.



Note: Please refer to the IDT (PC version) user-guide.
The above user-guide is written primarily for a multi-purpose data logger, however many of the IDT functions and settings are common to the PermaNet+ device. Where this is so, they will only be mentioned briefly in this guide.

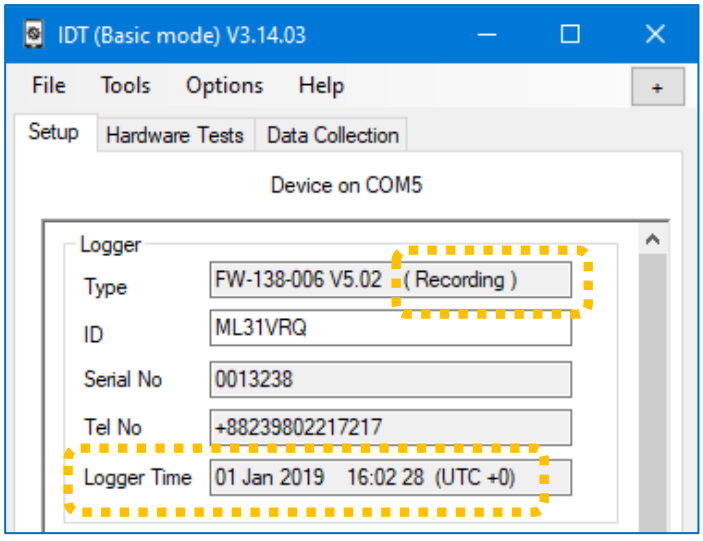
The PermaNet+ operation is not that of a general-purpose data logger but has its own specialised leak determination programs. This user-guide will cover details of the program operation and the relevant additional settings for it.

Note: When IDT starts it checks whether a new version is available; If so, it is recommended to download it to keep the software up to date with any new features or bugfixes.
Similarly, when IDT reads the PermaNet+ logger details it may advise that a new version of software is available for the logger itself. If so, it is recommended to update it before commencing.
Refer to the IDT user-guide (if required).

3.2.3 Displaying logger device information / logging status

After reading the PermaNet+ device's programmed settings, the current recording status of the Logger panel in the Setup tab.

Note: Ensure that prior to leaving an installation site, the unit is in a state of "Recording", as shown.

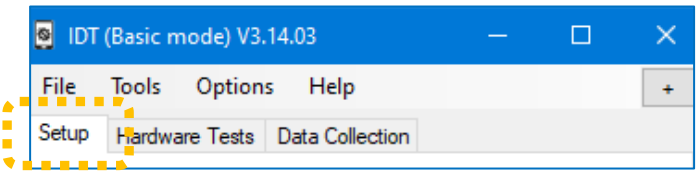


The logger date and time should also be the *local time* for wherever the logger is installed. Confirm this is the case before proceeding. The offset of local time from UTC is shown in brackets.

The remaining contents of this panel (ID, serial number, telephone number) are discussed in the IDT manual.

4 CONFIGURING THE PERMANET+ LOGGER

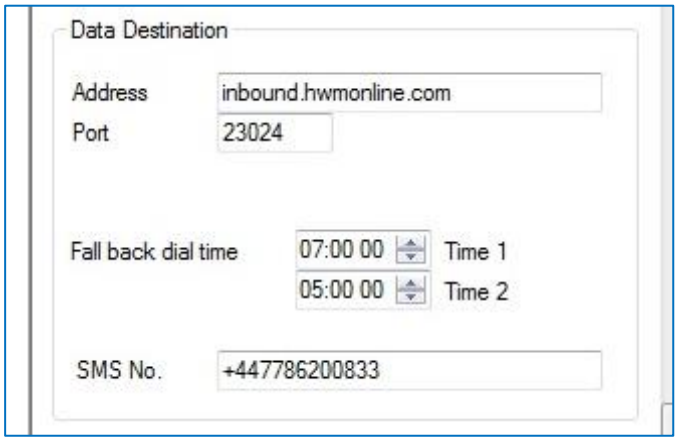
4.1 SETUP OF REGULAR REPETITIVE PERMANET+ PROGRAM



To configure the logger, first select the Setup tab in IDT.

The IDT display is adaptive in behaviour and shows information and controls which change depending on previous selections / de-selections.

The Setup tab is divided into various panels of related settings.



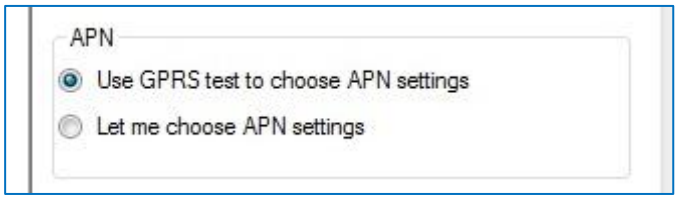
One panel has settings for where to send the results.

The method chosen:

- Internet packets (preferred) or
- SMS messaging (fall-back option, if available)

... will depend on whether there are any issues in obtaining a suitable signal from the cellular network (e.g., adverse weather), or if the external battery (if supplied) has become exhausted.

Refer to the IDT guide for guidance.



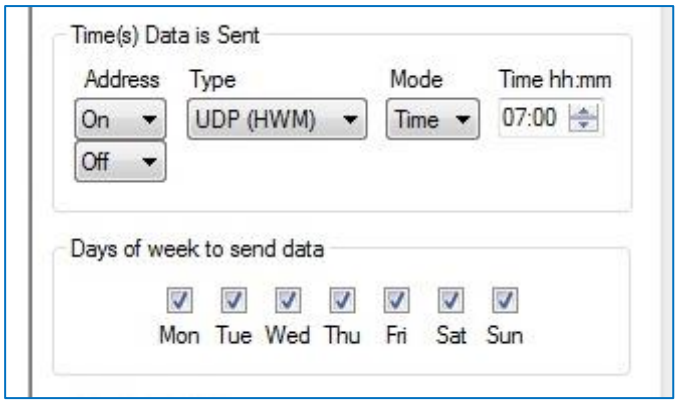
One panel has settings for determining how the logger will gain access to a cellular network (e.g., selection of a suitable operator and access permissions).

Refer to the IDT guide for guidance.

There are 2 panels that determine the primary method the logger uses to send data when it calls into the server. They include a setting for the call-in time and also which days of the week to call in.

Any unsent data will be sent at next call-in time.

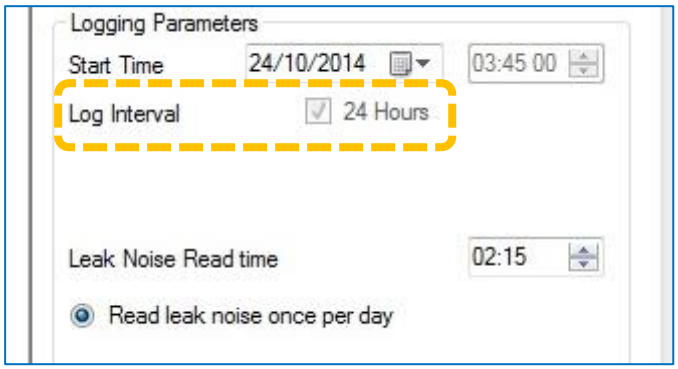
Refer to the IDT guide for guidance.



The controls for the hydrophone sensor, leak determination program cycle, and other relevant data items are found in the "Logging Parameters" panel.

Leak determination using the hydrophone normally is set to occur once per day. This is shown here by the log interval of "24 hours" being selected.

The "Leak Noise Read time" field controls the time (24-hour clock) when the leak determination program is run with the Hydrophone.

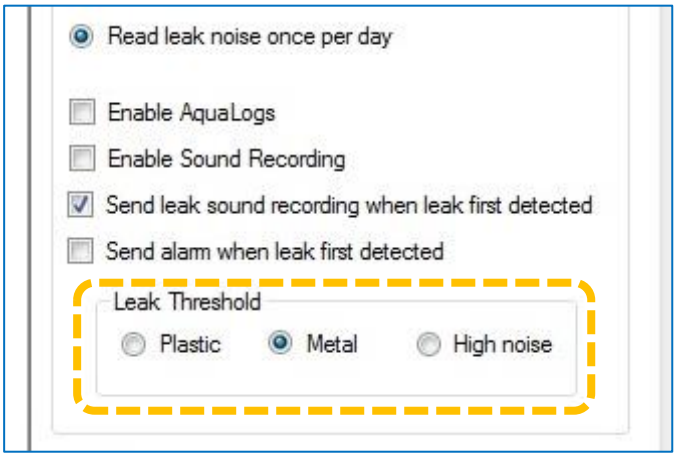


It is usual to set this to a time when the water network has minimal noise, such as when it is in minimal use (usually in the early hours of the morning).

Note: The entire system should have timings set to work in a co-ordinated manner. Leak determination by the PermaNet+ should occur close to the optimum (quiet) evaluation time. Sufficient time should however be allowed for any confirmation checks by the unit but must occur before data is sent into the server.
The server, in turn, should have received data from the PermaNet+ unit prior to the typical start of the working day so that a recent evaluation of the state of the PermaNet+ fleet is available for users early in the day.

One section of the Logging Parameters panel is a “Leak Threshold” selection.

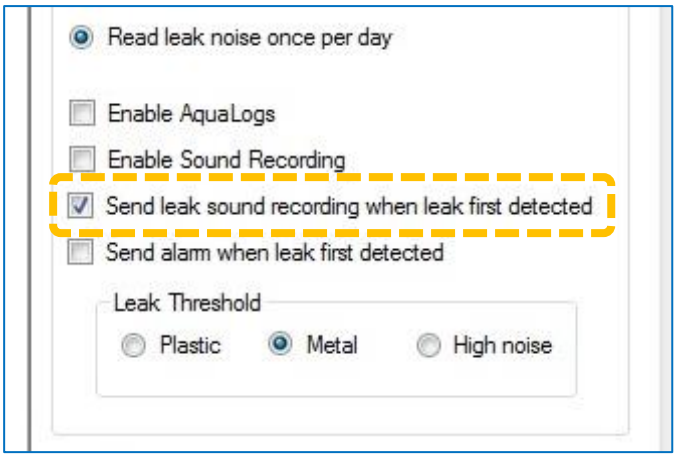
This determines which threshold is being used as the judgement of a leak / no-leak condition during leak determination.
(i.e., it is a sensitivity control).



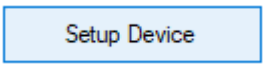
The “send leak sound recording when leak first detected” control will
(when set) cause the PermaNet+ unit to make a short recording of the pipe noise if it judges that a new leak is present.

The recording lasts typically for 10 seconds.

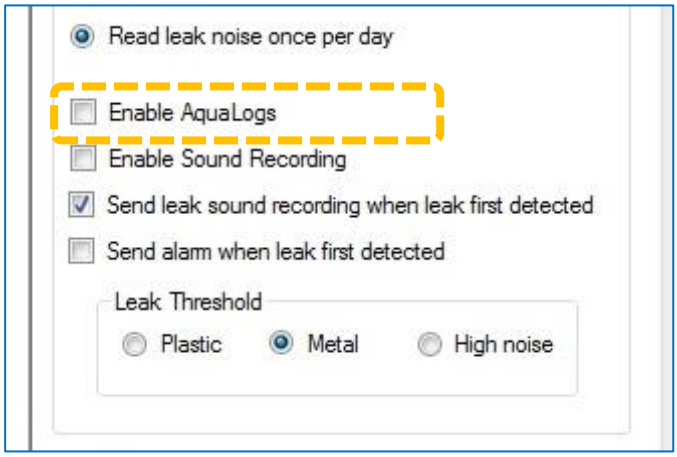
The recording is stored in the logger and will be uploaded to the server at next logger call-in. A user can then listen to the noise (played back from the server) to form an opinion as to whether it sounds like a leak.



The IDT-PC program stores the new settings in the PC memory.
To save then into the PermaNet+ unit, click on the ”Setup Device” button in IDT.
(This is located towards the bottom of the Setup tab).



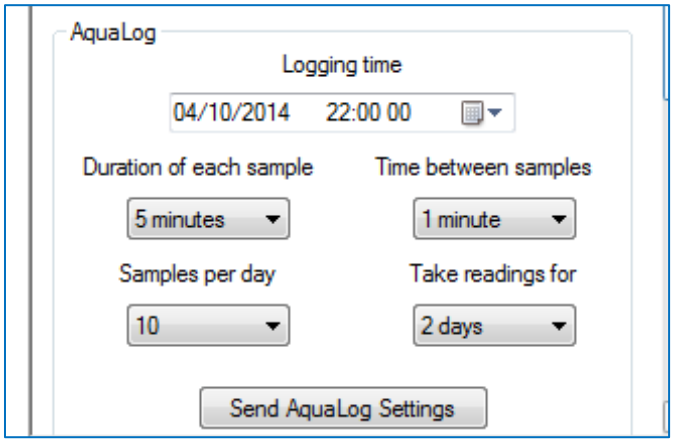
4.2 ADDITIONAL DATA FROM A 1-TIME PROGRAM - AQUALOGS



The "enable aqualogs" control will (when set) cause the PermaNet+ unit to produce Aqualog data.

Aqualog production is a temporary addition to the logger's regular task of leak determination.

Enabling Aqualogs causes IDT to show another panel for the Aqualog settings



An Aqualog produces data for a histogram of the noise levels that appear on the water network. More precisely, it can produce several sets of data for histograms, collected at different times.

The start time is selected using the "logging time" control; enter a date and time to commence.

The "Duration of each sample" sets the length of the Aqualog data collection cycle.
The "Time between samples" is the pause time before beginning the next Aqualog data collection cycle (if any are still pending for the current day).
The "Samples per day" sets the number of times the Aqualog data collection cycle should be run during each day.
The "Take Readings For" control sets the number of days the daily cycle should be repeated.

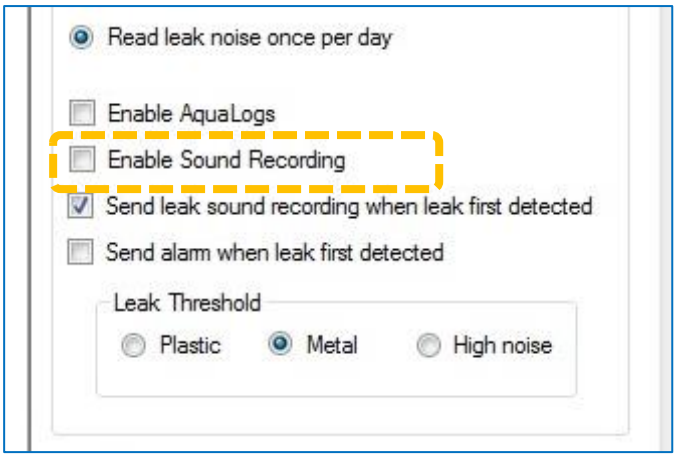
When the Aqualog panel settings are complete, click the "Send Aqualog Settings" button. This will upload the temporary additional logging task to the unit. The Aqualog data will be uploaded to the server and can be viewed once the data has been produced and stored.

4.3 Additional data from a 1-time program – Sound Recordings

The “enable sound recordings” control will (when set) cause the PermaNet+ unit to produce additional sound recordings.

The production of these sound recordings is a temporary addition to the logger’s regular task of leak determination.

The recordings will be made independent of any leak judgement (i.e., whether a potential leak is detected or not).



Enabling Sound Recording causes IDT to show another panel for setting the temporary program cycle for obtaining the additional Sound recordings.

This must be completed in a similar manner to those available for Aqualogs.

When the Aqualog panel settings are complete, click the “Send Sound Recording Settings” button.
This will upload the temporary additional logging task to the unit. The Sound recordings will be uploaded to the server and can be played back from the server once they have been produced and stored.

5 INSTALLATION

5.1 INSTALL LOGGER

Diagrams of typical installations of PermaNet+ with Hydrophone are shown (opposite and below).

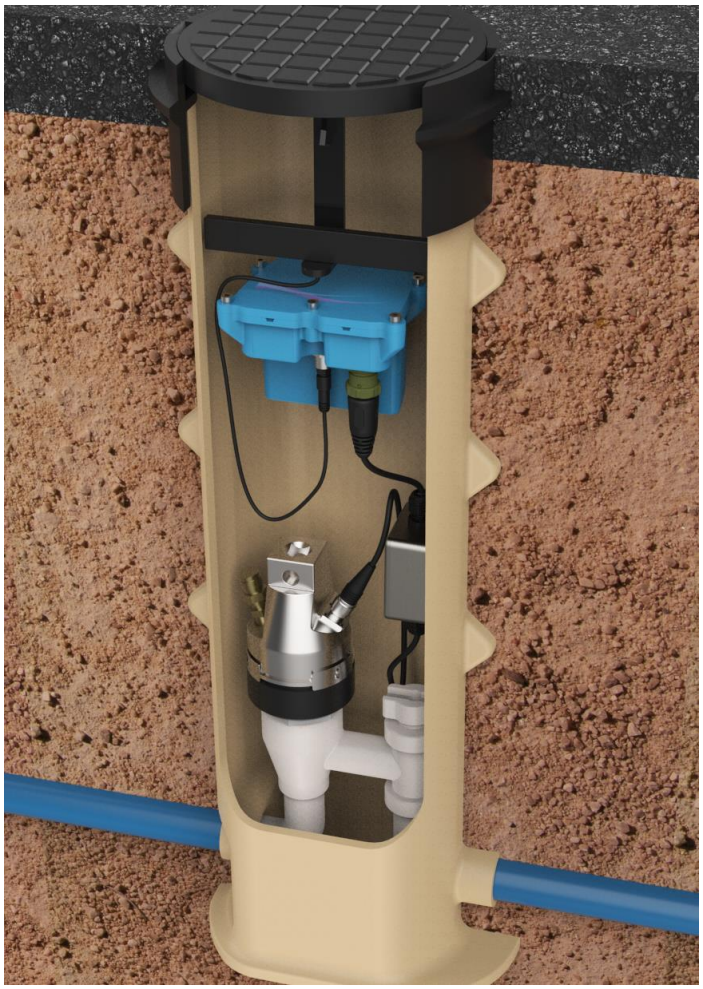
The PermaNet+ unit must be mounted in a suitable location where the Hydrophone attached can reach its intended installation point.

Position the equipment and antenna away from sources of electrical interference such and motors or pumps.

Ensure the antenna can be mounted in a suitable location where the radio signal will be of sufficient strength to call into the cellular network.

Cables should be positioned so as to not cause any hazards. Do not allow any equipment to rest on cables or connectors as crush damage can result.

The logger should be installed in the orientation shown for optimum battery performance.



5.2 CONNECTION OF HYDROPHONE TO A FITTING

Remove any caps from the fitting you will be attaching the Hydrophone to and gently flush out any dirt and debris. Then close the fitting again and inspect for cleanliness whilst following any applicable water hygiene guidelines.

If using the London Round Thread adaptor, first lightly coat the internal rubber seal with silicone grease.

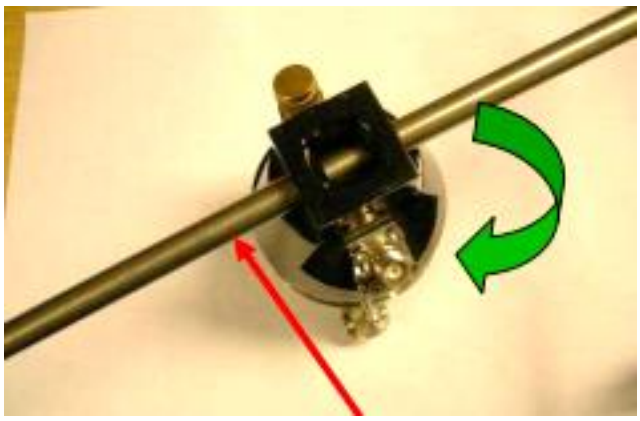
Apply a light coat of silicone grease to lubricate the adaptor and hydrophone sensor screw threads.

Note: DO NOT seal the threads between the Hydrophone sensor and the London round thread adaptor (or meter box) with PTFE tape or any other sealing material, as this could irreversibly lock the threads together.

Fit the London round thread adaptor to the Hydrophone sensor taking care not to damage or cross the threads. (see ⬅)

Tighten the adaptor until the castellations fitted to the top of the adaptor are secured by the quick release interlocking mechanism fitted to the Hydrophone sensor. (see ↔)

The Hydrophone may then be fitted to the Hydrant and tightened using a 'Tommy bar' Valve key, or ½" square drive tool.



Note: Overtightening, or continual use without lubricant will damage the sealing washer.

Note: If fitting the Hydrophone to a Fire Hydrant or boundary box that requires a different adaptor to be fitted, use the relevant adaptor for the fitting and follow the same process.

Unscrew the waterproof connector cover and connect the Hydrophone to Digital interface box lead to the hydrophone. Ensure the connection clicks home so that it is water-tight.

Note: Should the hydrant location be flooded, ensure that the lead is connected prior to immersion .
The sensor connector is only water proof after connection.

Open Hydrant valve fully to allow water into the hydrophone. A fully open hydrant valve will give the best noise transmission to the Hydrophone.

Remove trapped air by opening the bleed valve and closing it once a steady stream of water indicates the air is completely expelled.

Ensure the Hydrophone does not leak from the main thread and tighten as necessary. Ensure that the Hydrant gland is not leaking. If the hydrant frost plug is 'blown' ensure it is re-inserted in order to eliminate another possible leak noise.

Connect the Hydrophone to the logger using the Hydrophone amplifier cable.

5.3 ACTIVATE LOGGER AND CONFIRM SETTINGS

Ensure the logger has been activated (see section 2.13).

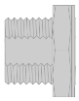
Connect to the logger using IDT and ensure the logger is in the “recording” mode; this is its regular operating mode. (See section 3.2).

Confirm the logger settings. Ensure the call-in destination is correct and that suitable call-in times have been set. Ensure the leak determination time is set to an expected quiet period on the water network.

5.4 INSTALLING THE ANTENNA AND TESTING CELLULAR COMMUNICATIONS

Only use HWM-provided antenna for use with your logger, to ensure the radio interface meets approvals requirements (safety, etc).

The PermaNet+ unit has a metal “FME” style connector for connection of an antenna.



FME

An antenna with the appropriate connector should be selected and attached, tightening finger-tight only. Always comply with any installation restrictions as per warnings in the documentation supplied. If possible, avoid locations where the antenna could be adversely affected (e.g., by an occasional flood condition).

- No sharp bends should exist in the cable routing of the antenna.
- Never bend the radiating element of the antenna.
- Where an antenna is held in place by magnets, ensure the weight of any cables does not excessively load the magnet so as to detach it from the installed location.
- Do not allow any equipment to rest on the antenna connector as crush damage to the connector or antenna cable can result.

IDT should be used to check that the logger can connect to the cellular network and that the antenna is suitable for use and in the optimal position.

- Choose a suitable antenna for the installation (see section 6) and decide on its initial position.
- Determine the network technology being used and the appropriate signal quality limits that should be used (refer to the IDT user-guide).
- Perform Network Signal tests to confirm the logger connects to the mobile network and find the best location of the antenna.
- Perform test calls to confirm the logger can communicate with the DataGate server via the internet and (if required) SMS.

Note: Follow the steps and guidance in section 6.
Details of use of IDT for making these tests are within in the IDT PC user-guide.

Trouble-shoot a test-call failure if required, using the advice in the IDT app user-guide. Further information is given in the HWM Antenna Installation Guide (MAN-072-0001), and on the webpage https://www.hwmglobal.com/antennas-support/

6 ANTENNA OPTIONS AND INSTALLATION GUIDELINES

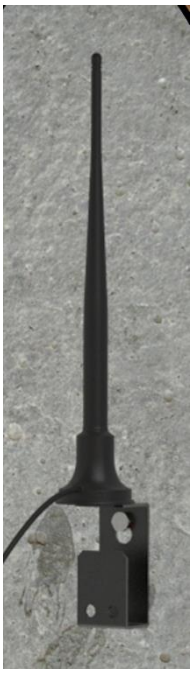
6.1 ANTENNA OPTIONS

This section describes a variety of the antenna alternatives that can be supplied for use with the PermaNet+ logger. Only use HWM-provided antenna for the logger, to ensure the radio interface meets approvals requirements (i.e., safety).

6.1.1 Monopole

For most installations a monopole antenna will give acceptable performance.

Installation Considerations

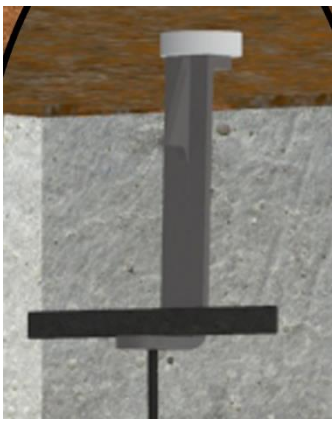


- The antenna has a magnetic base to be used for mounting.
- For optimum performance the antenna requires a "ground plane" (metal surface). Consider installing a metal bracket made of a ferrous material to attach the magnetic base of the antenna, if space allows.
- Install the antenna close to the surface in large underground chambers.
- Ensure that the lid will not interfere with the antenna or cables when being opened/closed.
- This antenna is vertically polarised, it should always be installed in the vertical orientation.
- Never bend the radiating element of the antenna.
- The antenna can also be attached to an installation bracket mounted to an existing marker post.

Illustration of installed logger and a monopole antenna:

6.1.2 T-Bar

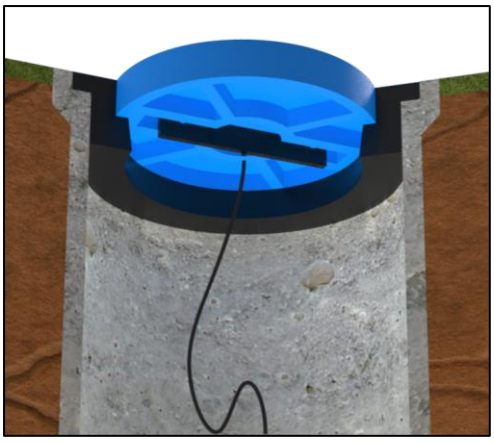
This antenna should be mounted at the top of the chamber. (Two examples are shown).

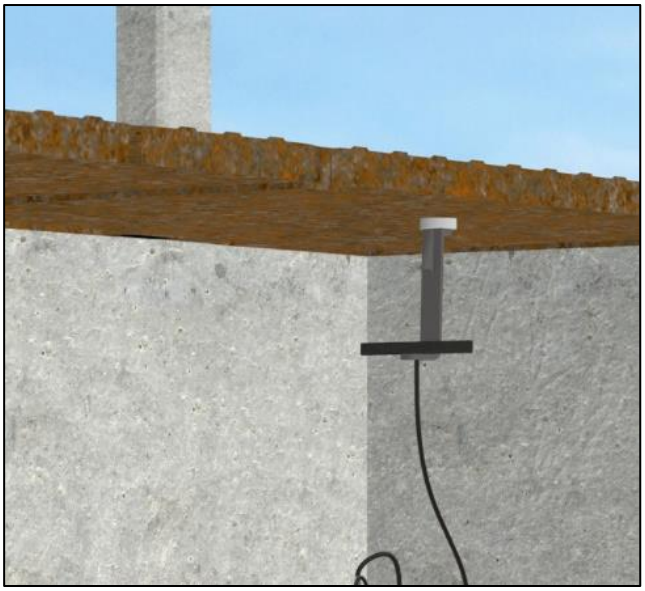


T-Bar Installation Considerations

- Mount the antenna at the top of the chamber, but spaced away from any metal lid.
- A bracket with magnetic mount is available to attach the antenna to a metal lid and also provide a gap; secure the antenna to the bracket using a tie-wrap.
- Avoid attaching the T-Bar directly to a metallic surface as this can adversely affect signal strength and performance, however it may be better than underground.
- Certain chamber lids can be replaced with a plastic version to which the T-Bar antenna can be mounted.
- Keep the antenna cable as short as possible, but allowing for installation and removal of the lid without damage or injury.

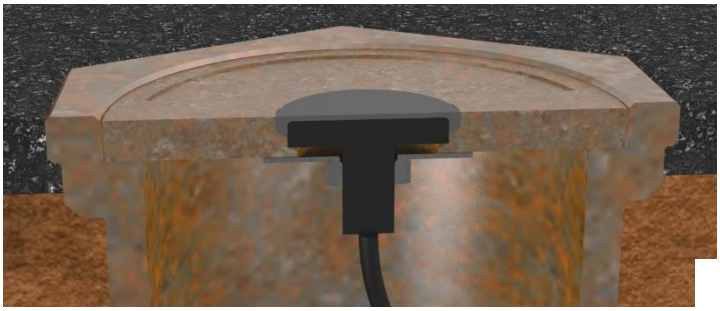
Illustration of installed logger and a T-bar antenna:
(2 alternatives shown: metal lid and a plastic replacement lid):

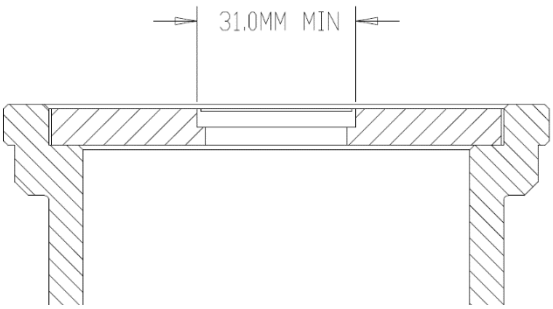




6.1.3 Button

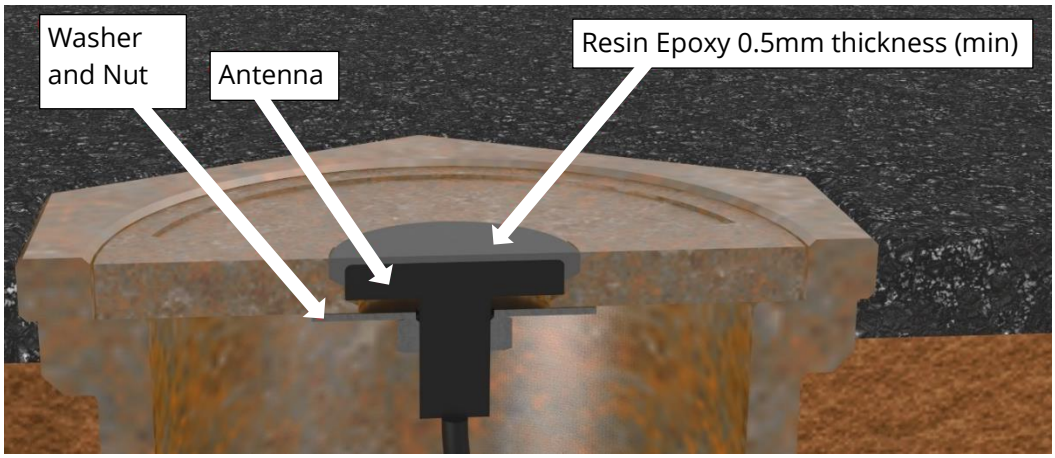
The button antenna is designed for mounting into chamber lids.





Button Antenna Installation Considerations

- The chamber lid is required to be drilled out to accommodate the body of the antenna.
- The top surface of the antenna needs to be a minimum of 0.5mm below the surface of the lid to prevent damage.
- Drill through the lid to make a path for the cable and connector to pass through.
- Drill partially into the lid using a wider drill to make a suitable countersink or recess that the body of the antenna can fit into. Check before drilling the recess that the size shown in the diagram still applies (the antenna supplied may be of a different size).
- Fasten the antenna using the nut supplied. A washer may be required.



- Once fitted, cover the top of the antenna with a resin epoxy such as “Marine Goop”. Ensure all surfaces are clean and dry before applying the adhesive. Follow the adhesive manufacturer’s instructions.
- Ensure the antenna cable does not become damaged (e.g. by the lid) during installation and use.

Installation pictures:

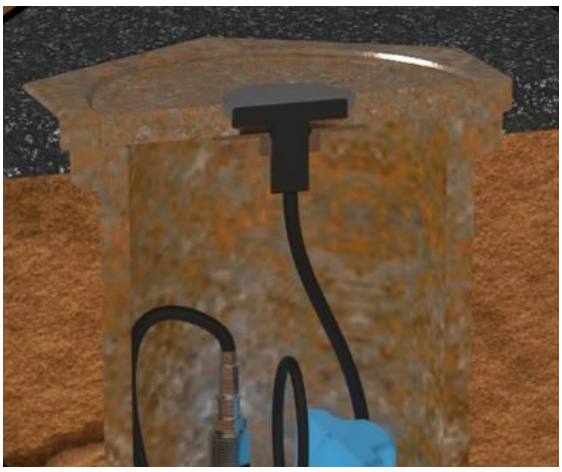
Drill hole in lid to provide a recess for the antenna body.

Thread antenna cable through hole, washer and nut.

Secure antenna to the lid using the washer and nut.

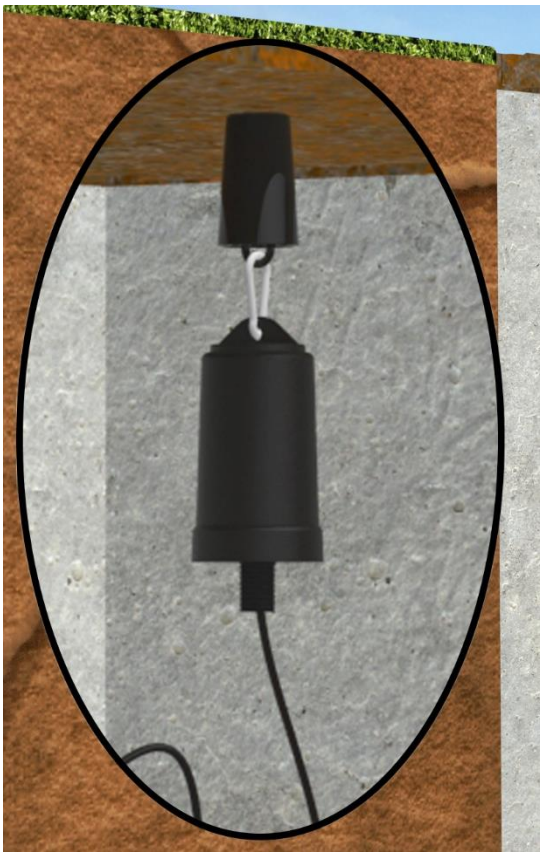
Apply a resin epoxy such as Marine “Goop”, covering the antenna to protect it.

Illustration of a completed button antenna / lid (connected to an installed logger):



6.1.4 Cone Antenna

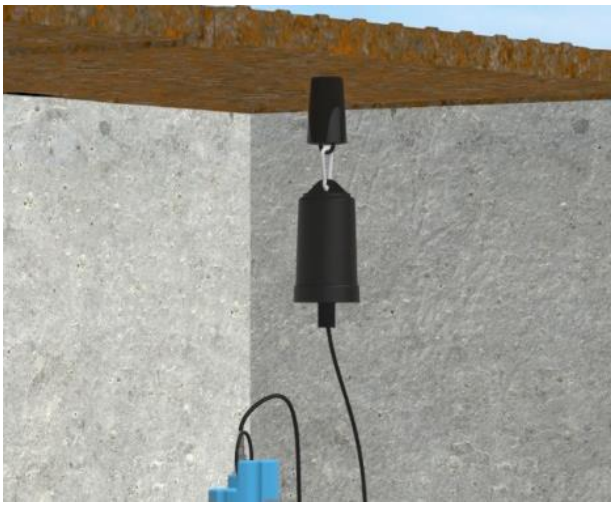
This antenna should be mounted at the top of the chamber.



Cone Antenna Installation Considerations

- Mount the antenna at the top of the chamber, but spaced away from any metal lid.
- A magnetic mounting hook is available to provide a gap. The antenna must be attached to the hook and suspended as shown.
- Keep the antenna cable as short as possible, but allowing for installation and removal of the lid without damage or injury.

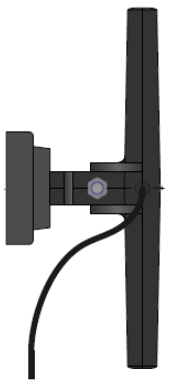
Illustration of installed logger and cone antenna:



6.1.5 Magnetic Dipole Antenna

This antenna is similar to the T-bar.

The magnetic mounting of this antenna makes it ideal for attaching to metal structures inside larger chambers.



Magnetic Dipole Antenna Installation Considerations

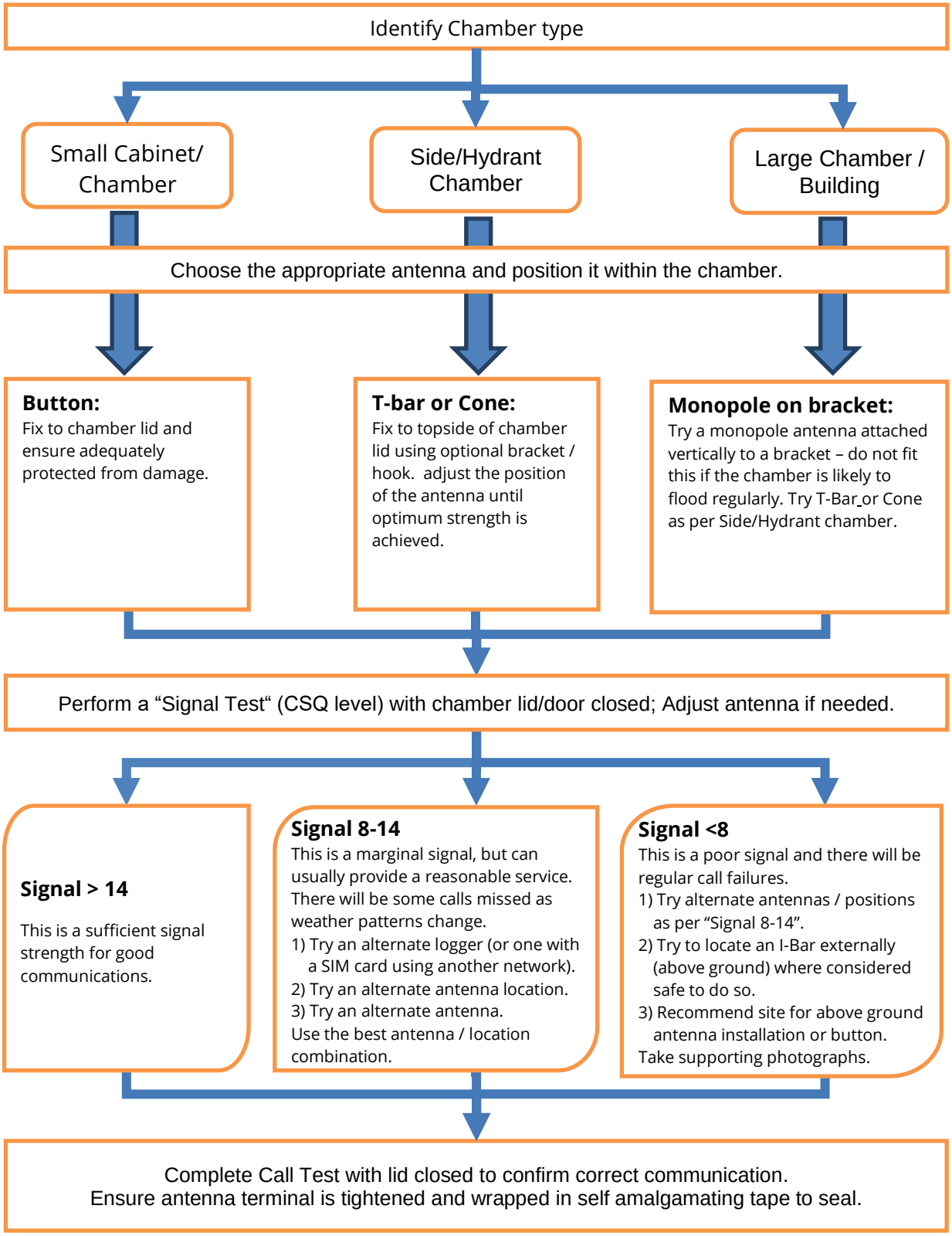
- Antenna can be attached to the side wall of a chamber or to the underside side of the chamber lid.
- Best installation is usually with the antenna vertically polarised.

6.2 INSTALLATION GUIDELINES

Every site installation is unique with various types of connections, positioning or environmental conditions possible, the following recommendations will assist in a reliable installation.

- Keep the equipment neatly arranged in chambers so that cables are not crushed.
- The logger and antenna are held in place by magnets. Ensure the weight of any cables does not excessively load any magnet so as to detach it from the installed location.
- Do not allow any equipment to rest on the antenna connector as crush damage to the connector or antenna cable can result.
- Position loggers away from sources of electrical interference such and motors or pumps.
- Carefully locate the logger onto the pipe (or tap) to avoid shock damage to the sensor. Always grasp the main body of the logger when placing or retrieving it from the pipe fitting. Do not pull the logger by any cable as this can cause damage.
- Always ensure that the contact point is free from dirt, so that the magnet makes a good contact.
- Maximum operating temperature of the Logger should be below 60°C, therefore if fitting to a hot water pipe, ensure a suitable insulation is used.
- Use the IDT program to check for the best location of the antenna before finalising its position. Refer to section **Error! Reference source not found.** for details of how to do this.

6.3 Installation Process Decision Tree



Troubleshooting a Call Test failure

There are a number of reasons why a Call test may fail.
The following points should be checked before calling HWM support for assistance: -

Possible Problem	Solution
Network Busy due to excessive traffic. Commonly occurs around schools and at peak travel times.	Retry the test after a few minutes.
Network signal not available at your location. Not all Cell masts carry data traffic	Relocate the logger to an area that has a data service or change to a different network provider.
Network signal not strong enough. You need a CSQ (reported by the Call test) of at least 8 for reliable communications.	Relocate the antenna if possible or try alternative antenna configurations.
APN settings incorrect.	Check with your network operator that you have the correct settings for your SIM.

If you continue to experience problems with communication, you may need to check the network coverage in your location.

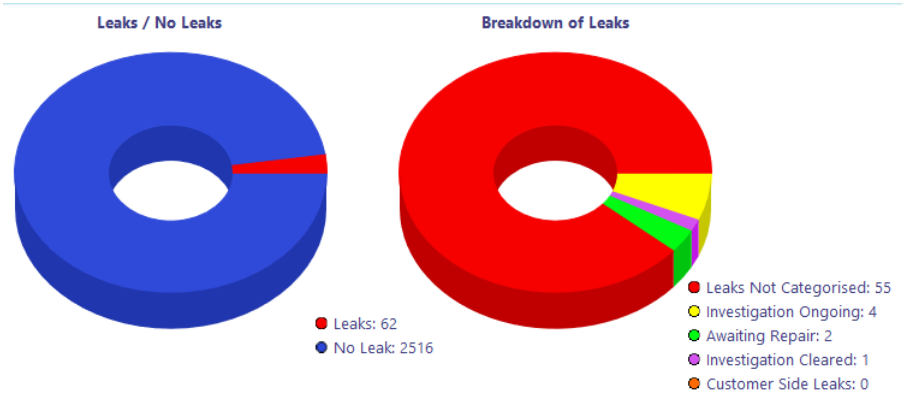
7 VIEWING YOUR DATA

Each logger calls into a server, where its data can be stored. The data is linked to the site on which the logger is deployed. The server therefore stores the current status (and historic data) for an entire fleet of loggers, linked to the sites on which they are deployed.

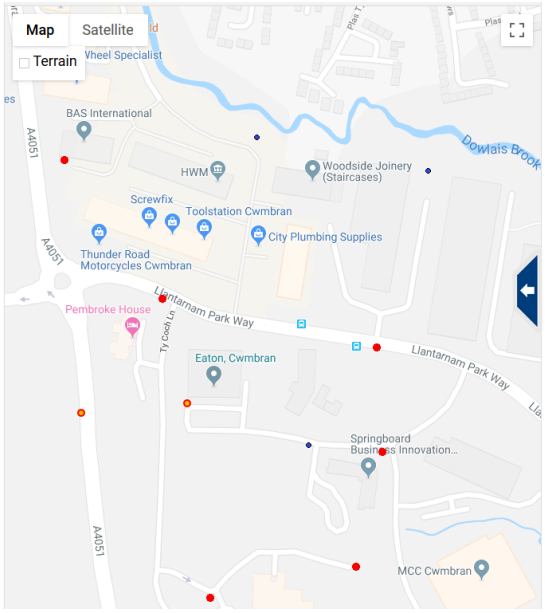
Site data is best viewed with the viewing tool (usually a website).
An example viewing tool for use with PermaNet+ devices is the HWM PermaNETWeb website.

PermaNETWeb can display the status of *multiple* devices (sites) simultaneously, thus allowing the state of an area of a utility network to be easily visualised.

This can be shown as a "dashboard" graphical status (see opposite).



Alternatively, the state of an area of a utility network can be visualised by showing each site as a coloured dot or icon on a background map (or satellite view) and the current leak determination status for the site (or the logger call-in status); see below.



Refer to the appropriate manual or training provided for your viewing tool for further guidance.

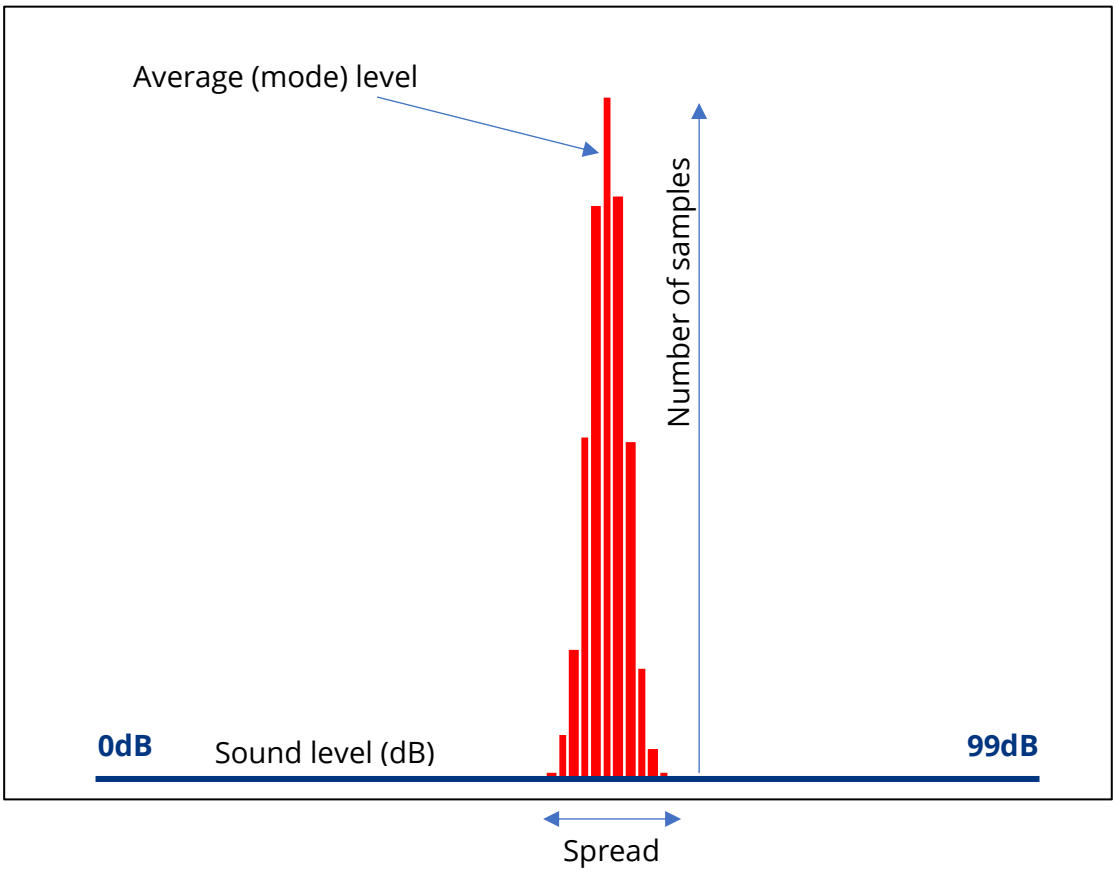
8 INTERPRETATION OF LEAK DATA

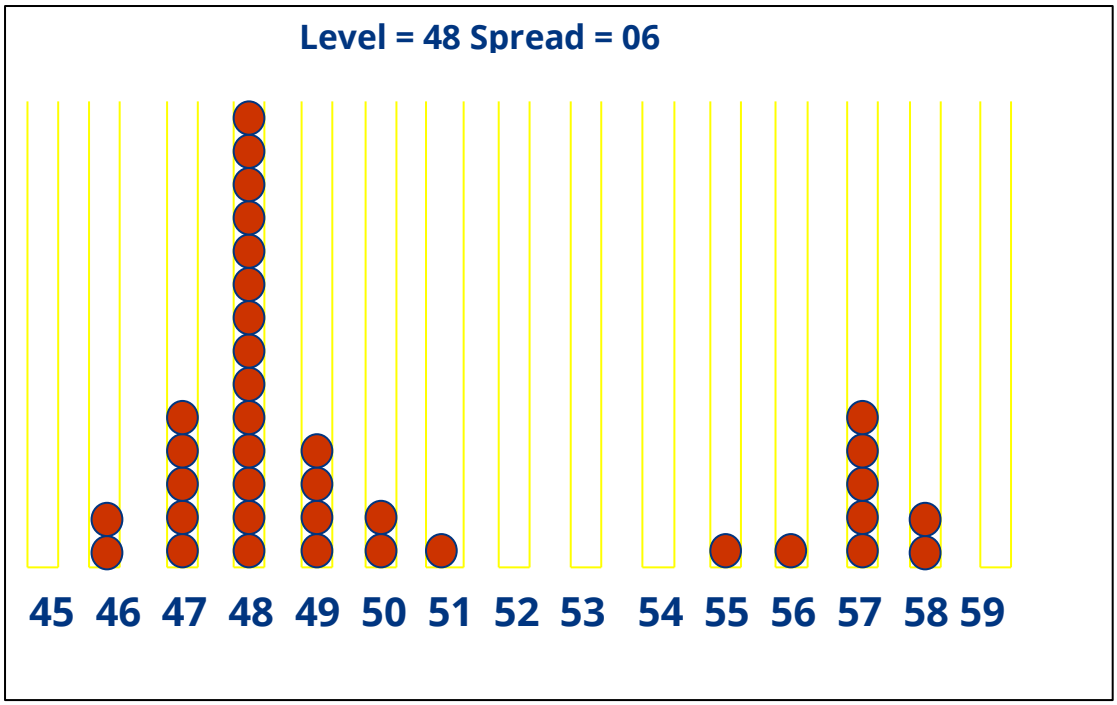
8.1 LEVEL AND SPREAD RESULTS

The raw sound level is measured on a scale between 0dB and 99dB.

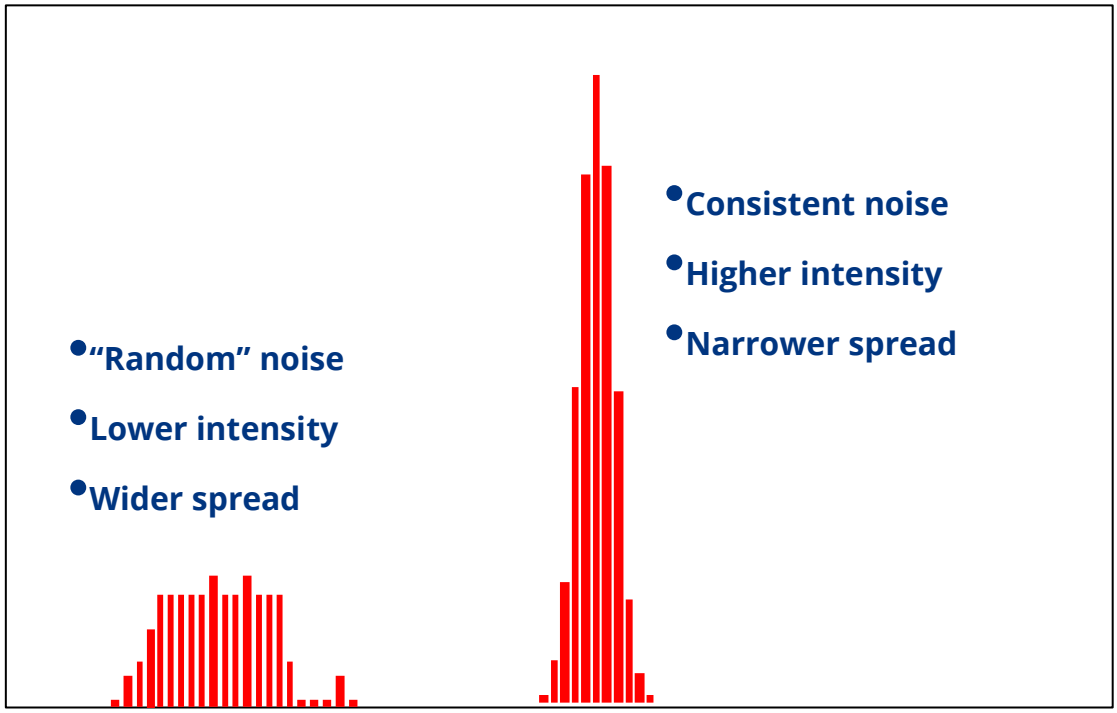
The signal **Level** (in decibels) is the point on the dB scale where there is a clearly identifiable peak.

The **Spread** is the width (number of dB values) that can be considered to be included within the over-all shape of the biggest peak.





Each test will provide different results depending on the ambient noise conditions at any given deployment. A leak will be indicated by a consistent noise generated at a higher intensity than any random background noise, so the best indication of a leak is a high peak with a very narrow spread, see example on the right below. The noise on the left is a probably not a leak as it is low intensity and broad spread.



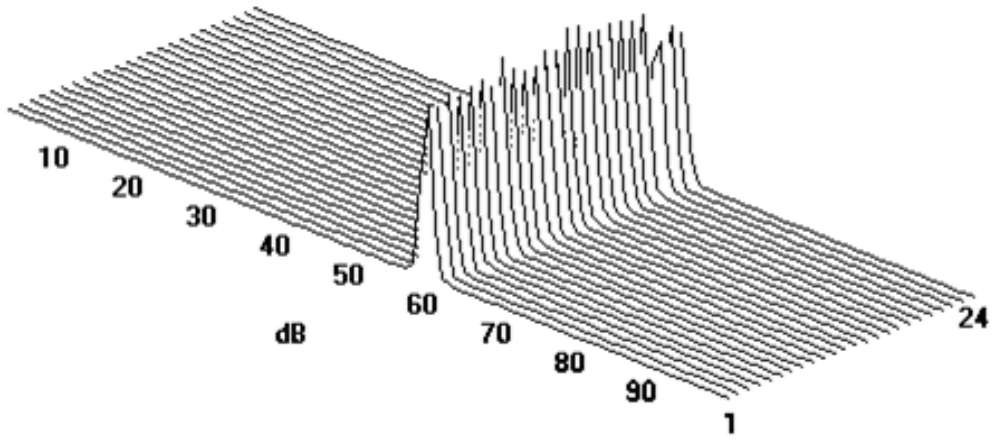
8.2 AQUALOG / HISTOGRAM RESULTS - EXAMPLES

The following section discusses how to read Histograms.

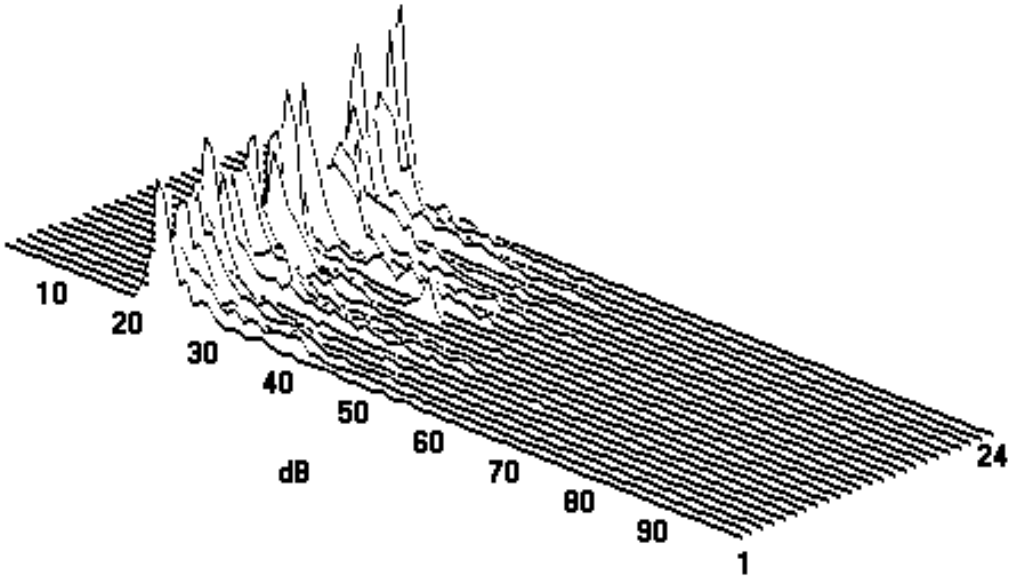
Note: A standard histogram is amongst the data received from the logger once per day. An 'Aqualog' is the same as a 'Histogram' but is manually triggered and has customisable timings.

Examples:

In the below example of a 'good leak indication,' measured over 24 days there is an average **Spread** of 5dB and **Level** of 58dB at the peak.
This shows a high repeatability of the leak noise.
Average Level = 58
Average Spread = 5



In the below example of a 'poor leak indication' again measured over 24 days, there is an average Spread of 27dB and Level of 21dB at the peak. This shows a poor repeatability of the leak noise.
Average Level = 21
Average Spread = 27

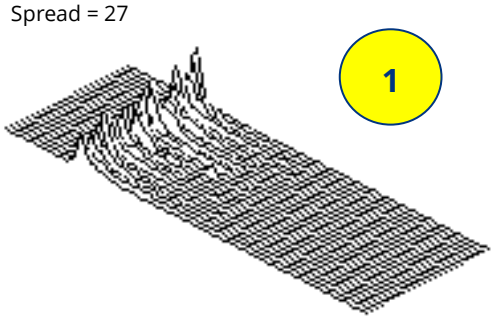


In the below set of examples the strongest leak indication is No 3 – a narrow spread (5dB) and a strong level (60dB).

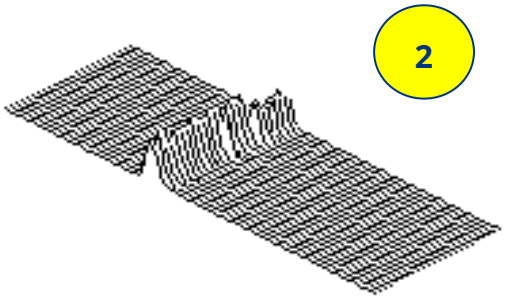
The others do not offer good indications of leaks:

No 1 … Big spread / poorly defined peak,
No 2 … Good spread but poor peak,
No 4 … Big spread / inconsistent peak.

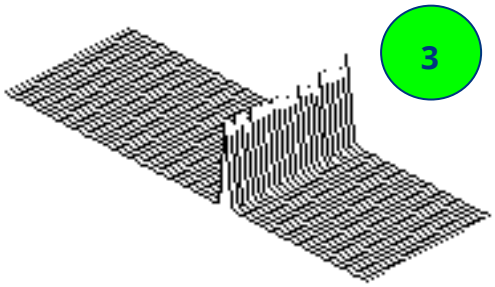
Average Level = 21
Spread = 27



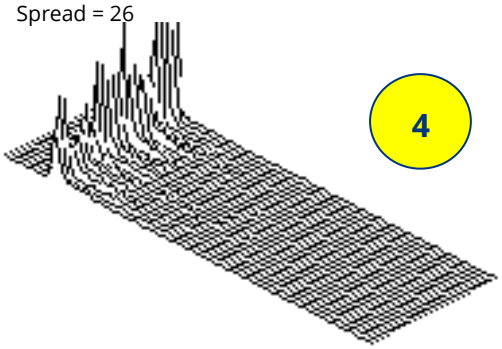
Average Level = 24
Spread = 9



Average Level =60
Spread = 4



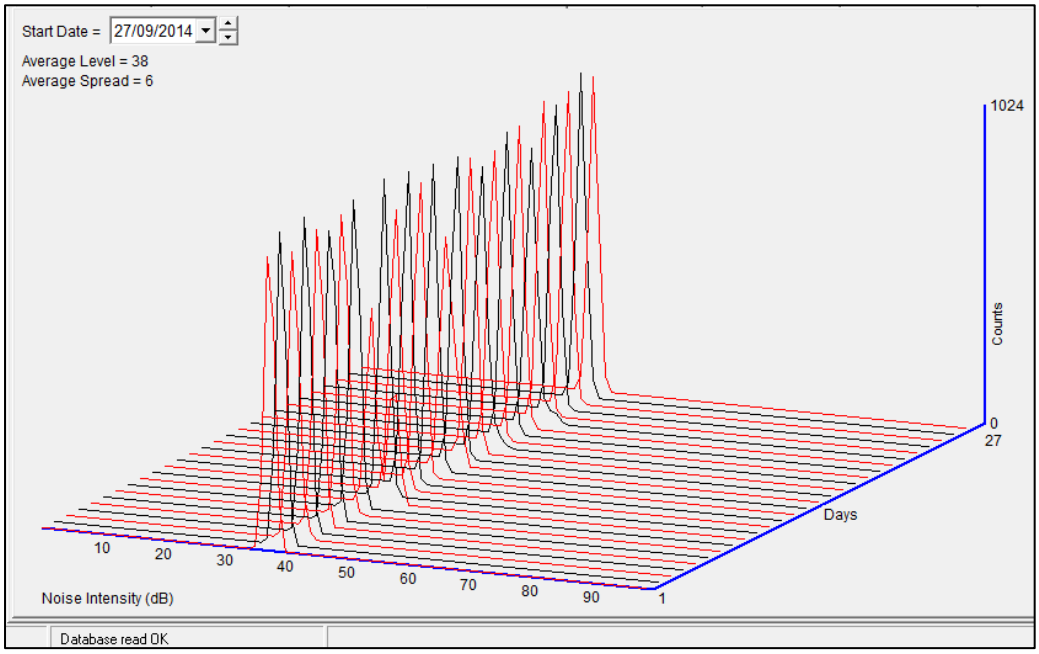
Average Level = 29
Spread = 26



In summary:

The best indication of a leak is with the highest consistent peak (noise) with the narrowest spread and the highest number of samples in it.

See below a typical PermaNet+ Aqualog screen shot showing a good example of a leak.



9 TROUBLESHOOTING

The data from the logger does not appear on the server:

- Check the settings for the SIM card to access the mobile data network.
- Ensure the logger uses the correct data destination URL and port-number for your server.
- Check call-in times have been set.
- Check antenna is attached and in an OK condition.
  Check signal quality and strength parameters are suitable. Re-locate the antenna, if required, or try an alternative type of antenna.
- Make a Call Test and confirm OK.
- Ensure your server is correctly configured to receive and present the data.

10 MAINTENANCE, SERVICE AND REPAIR

Unauthorised servicing will void the warranty and any potential liability for HWM-Water Ltd.

10.1 REPLACEABLE PARTS

Antenna

- Only use antenna recommended and provided by HWM.

For details of antenna options and part-numbers to order, refer to the following link: https://www.hwmglobal.com/antennas-support/

Batteries

- Only use batteries and parts recommended and provided by HWM.
- Batteries are only replaceable by a HWM approved service centre or relevantly trained technician. Contact your HWM representative for more details if required. A battery swap must be accompanied by a reset of power-use counters for the logger to perform normally.
- Batteries can be returned to HWM for disposal. To arrange the return, complete the on-line RMA form: https://www.hwmglobal.com/hwm-rma/
  Refer to the Safety Warnings and Approvals Information for guidelines of the packing requirements.

SIM-card

- SIM-cards are replaceable by a HWM approved service centre or relevantly trained technician.
- Only use consumable parts recommended and provided by HWM.

10.2 RETURN OF PRODUCT FOR SERVICE OR REPAIR

When returning product for investigation or repair, be sure to follow the instructions of your distributor to document why the product is being returned and provide contact details.

If returning to HWM, this can be done by completing the on-line RMA form: https://www.hwmglobal.com/hwm-rma/

Prior to shipping, put the equipment into Shipping mode (refer to the IDT app user-guide for instructions). Refer to the Safety Warnings and Approvals Information for guidelines of the packing requirements.

If soiled, ensure the unit is cleaned with a mild cleaning solution and soft brush, disinfected, and dried prior to shipment.
Any cleaning must be done outside of an ATEX environment.

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