Manual   EN

GUTERMANN

ZONESCAN NET – Version 2.1

Table of Contents

1 Indications for Use

It is essential to read the operating instructions carefully and completely before using the first time the equipment and software. They contain important information on safety, installation and use. Keep these instructions in a safe place.

1.1 Symbols

⚠️	**Warning of dangerous situations that can cause injury and damage to the devices.**
🚫	**Warning** **The ZONESCAN Correlating Radio Noise Data Logger contains a very powerful magnet. The operation of cardiac pacemakers and implanted defibrillators can be influenced. People with cardiac pacemakers and implanted defibrillators are not permitted anywhere near this product.**
ℹ️	**Important notes and tips. Follow these guidelines.**
🗑️	**Never put in your household waste bin.**

1.2 Safety

⚠️ The operating and maintenance personnel must read carefully the instructions before operating. Knowing all the information contained therein - in particular the warning and safety instructions - is needed to safely operate the equipment. To protect yourself and others against possible dangers. Ignoring the warning, safety and operating instructions can result to a considerable shortening of the useful life of equipment. Do not make any intervention, changes and alterations to our products. Never open the device, otherwise any warranty and conformity expires. For questions concerning replacing the

battery, please contact your Gutermann distributor. If you use the software and associated mobile equipment, pay the necessary attention particularly in traffic.

1.3 Warning

The ZONESCAN Correlating Radio Noise Data Logger contains a very powerful magnet. The operation of cardiac pacemakers and implanted defibrillators can be influenced. People with cardiac pacemakers and implanted defibrillators are not permitted anywhere near this product.

ZONESCAN S-Alpha does emit electromagnetic fields in operation. To protect your health, keep a distance of at least 8 inch (20cm) from the device and its antennas. Installation of the device has to be performed in such a way that this minimal distance is maintained under all circumstances.

1.4 Intended Use

ZONESCAN products, hardware, software and accessories, are exclusively intended for industrial use and exclusively intended for leak detection on water pipes of the public water supply. In particular, these products are not intended for the use of waste water and gas lines. Gutermann Technology GmbH is not liable for any damages caused by misuse, improper operation, and as a result of non-compliance with safety instructions and warnings.

2 Introduction

Gutermann Technology has developed the ZONESCAN NET System for professional leak detection in public drinking water pipelines. This unmanned, acoustic leak monitoring system with noise level and correlation measurements ensures that leak detection specialists are deployed only at the actual leak locations.

2.1 Main Features

Continuous leak monitoring of the entire water network

Distributed over the entire water network, ZONESCAN Loggers continuously monitor and analyze the noise characteristics and can thereby detect the presence and location of leaks.

Extensive leak database allows for a permanent reduction in water loss

Each data Logger stores the leak analysis results, including the detailed noise level distributions which are transferred to the ZONESCAN NET via the Repeater and Alpha array. This measurement data is automatically stored in the powerful ZONESCAN NET database. This is used to produce detailed logs for the maintenance personnel and, ultimately, a systematic analysis of historical data for optimizing future water network planning.

Integration of GPS in the ZONESCAN NET System

The ZONESCAN Net System offers the possibility to integrate GPS for automatically importing noise level and correlation data.

2.2 System Overview

The ZONESCAN Correlating Radio Noise Data Loggers are mounted directly in the water network to record and to save the existing noise level and the ambient temperature. The statistical analysis of the stored values indicates whether or not a leak is present. A number of strategically mounted ZONESCAN Correlating Radio Noise Data Loggers allow all segments with water losses to be identified.

The data measured by the logger is collected by the repeaters, which are mounted above ground. The repeaters then transmit the data via radio signal to the alphas. The collected data is then transmitted by means of GPRS (General Packet Radio Service) via the alpha to your ZONESCAN NET Program for further processing.

The software automatically evaluates the collected data daily. The more exact the pipe data entered by the user, the better the results. The results calculated in ZONESCAN NET are numerically and graphically presented in the form of histograms and frequency distributions, interpretation of the statistical evaluation facilitating the identification of the leak locations. A numerical leak indicator simplifies the interpretation of the statistical evaluation.
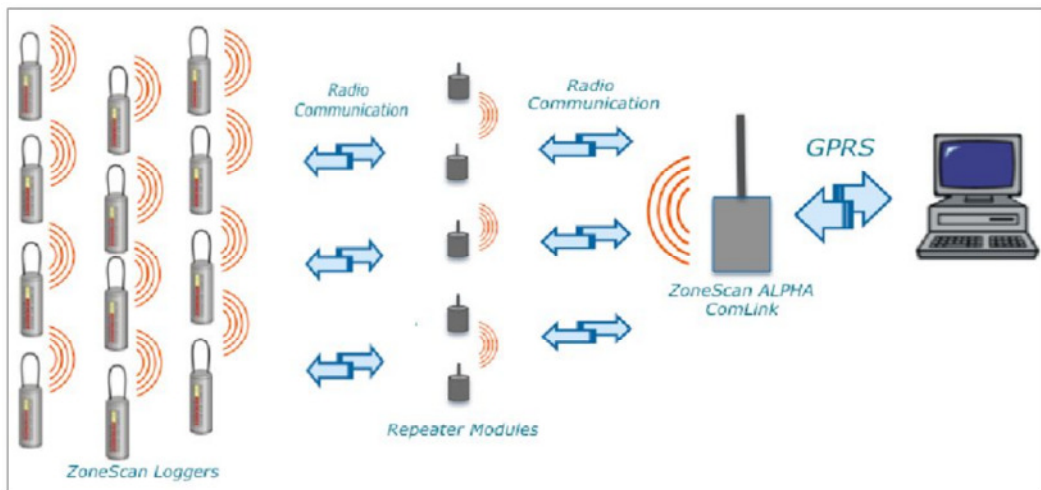
Figure 1: Functionality of logger, repeater and alpha

Interactive communication between ZONESCAN NET and the leak detector

While conventional radio loggers are equipped with a simple radio transmitter, the ZONESCAN Correlating Radio Noise Data Loggers feature a transceiver (combined transmitter and receiver). This allows for interactive communication between the sensor located in the chamber and the leak detector. In addition to correlation and remote listening, programming of the ZONESCAN Correlating Radio Noise Data Loggers is also performed via radio signal directly from the vehicle (i.e., without physical contact with the logger). Thus, the factory settings can be easily adapted at any time by you to meet your specific measurement needs.

3 Leak Detection View

3.1 Leak Detection Map

3.1.1 Structure of the Screen

Note! If the alpha fails, no data can be collected by the repeater and the logger and transmitted
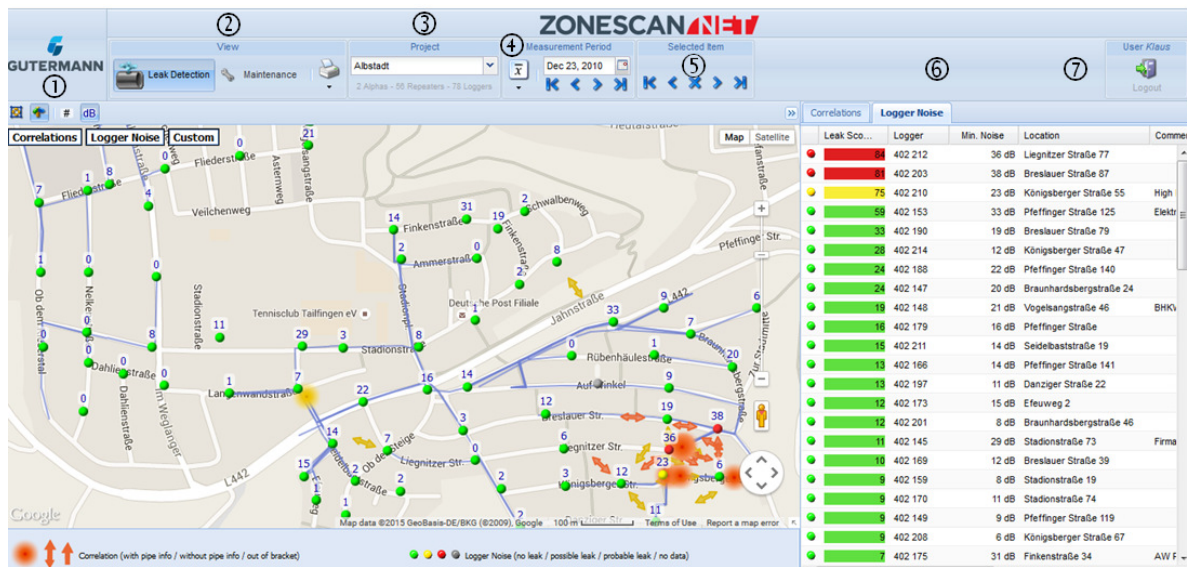

Figure 2: Structure of the screen with numbers ① to ⑦ for explanation

① **Map Area**

The Map Area contains a map by *Google Maps* with the area of the selected project. Use the buttons located above the map to execute various functions which vary depending on ② "View" - Leak Detection or Maintenance. For an explanation of the individual functions, hold the cursor over the button.

The buttons in the upper part of the map can be used to display and hide individual elements of the map. Depending on ② "View" - Leak Detection or Maintenance - the correlations, leak values and custom or alpha, repeater, logger and custom fields are displayed. Changes made here affect the view in ⑥ "List Area". By default, a legend is displayed in the lower part of the map.

② **View**

In View, you can switch between Leak Detection, Maintenance and Administration. Use the printer drop-down menu to print the screen, the map, correlated leaks or the leak values.

③ **Project**

In the Project menu bar, the user can select the desired project via the drop-down menu. ④ **Measurement Period**

The measurement period can be changed in the drop-down menu. Select from 5 days, 30 days or an entire month. The current setting is displayed at the right.

⑤ **Selected Item**
Use the blue arrow buttons to change between the individual values in the list area. The current selection is displayed in the upper area.

⑥ **List Area**
In List area, the user finds all data relevant for the evaluation.

⑦ **Logout Button**
The user logs out with the logout button.

3.1.2 Google Maps Area

The *Google Maps* Area has the regular *Google Maps* features such as changing the map view to satellite and terrain (beneath the Map field)
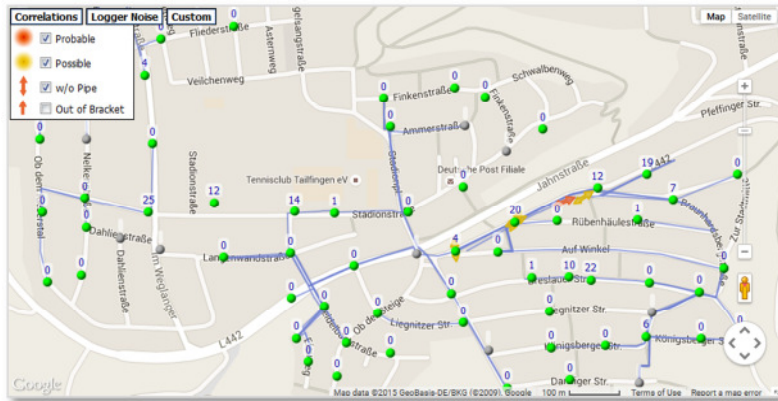

Figure 3: Google Maps Display

Figure 4: Google Satellite Display
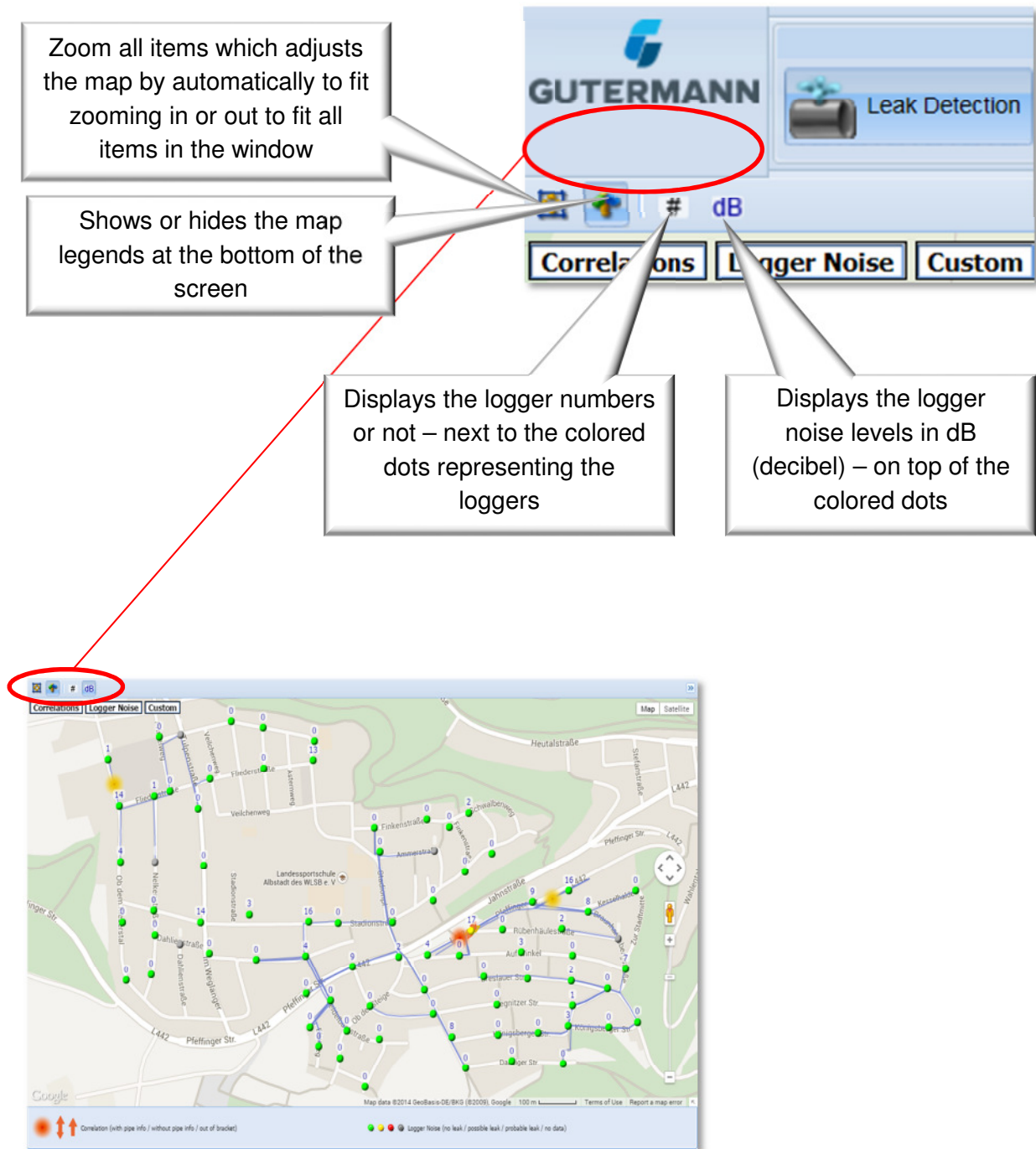
Figure 5: In the top left corner all four symbols are explained in speech bubbles

Zoom all items which adjusts the map by automatically to fit zooming in or out to fit all items in the window

Shows or hides the map legends at the bottom of the screen

Displays the logger numbers or not – next to the colored dots representing the loggers

Displays the logger noise levels in dB (decibel) – on top of the colored dots

Figure 6: Zoom In/Out

The *Google Maps* Zoom Slider allows one to zoom in or out

Google Street View

This powerful function that *Google Maps* have introduced allows the user to view and walk through the photographed 3D streets. If there is an orange *Pegman* present above the zoom bar then *Google Street View* is available.

Follow the link for further detail about using *Google Street View:*
https://support.google.com/maps/?hl=en#topic=3092425

Figure 7: Google Street View

This is location dependent as not all countries, cities or towns have street view available.

Figure 8: Google Street View Pegman (red circle)

- Hover the cursor over the orange *Pegman* and he will lean forward as shown above
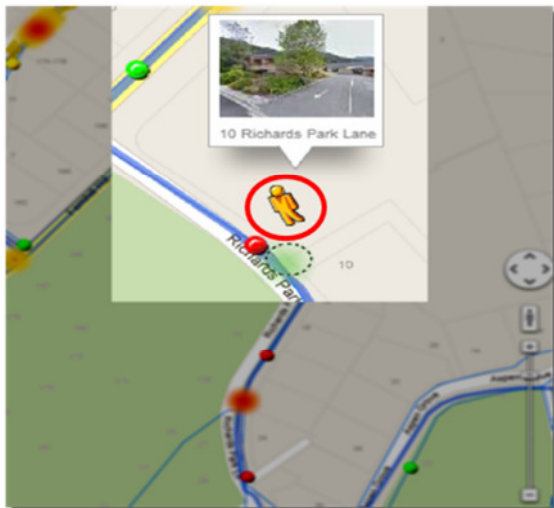

Figure 9: Google Street View moving the Pegman (red circle)

- Click and hold the cursor on the person then drag him to a chosen location on the street which will highlight blue to show which streets have the street view present. Simply release the mouse button to drop him on the street

Figure 10: Google Street View 1st person perspective

- The map changes to a photographic image of the street with the ZONESCAN Logger plotted in in place. The street names are marked and the white arrows are used to track forward or back through the street

Figure 11: Google Street View 1st person perspective – cont.

- The user is able to turn 360degrees on the spot by moving the cursor left or right until a rectangular white shadow appears, simply click the mouse to move in the chosen direction. The top left corner has the orientation wheel and zoom function bar similar to the normal *Google Maps*
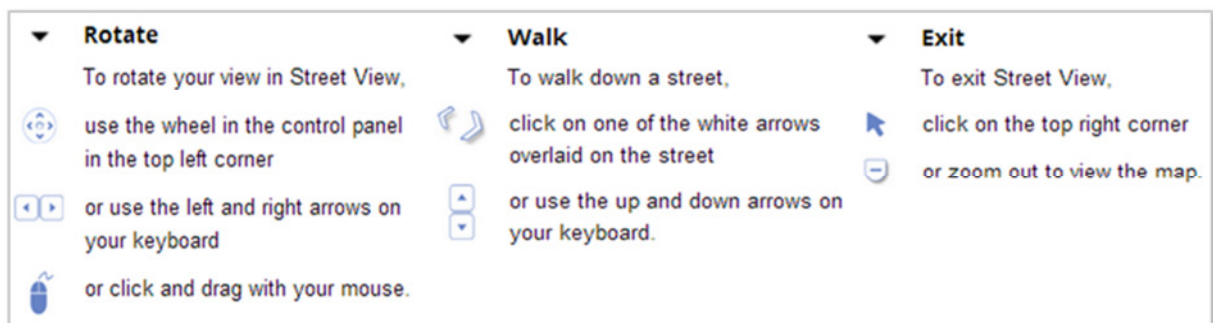

Figure 12: Google Street View Guidance

Figure 13: Google Street View Correlation Point (red circle)

An orange fuzzy spot plotted on the road represents a correlated point for further investigation. This is a very powerful remote tool for the leakage technician to further investigate.

3.1.3   Correlations and Logger Layer

The user may choose their correlations and logger display preferences by ticking the relevant box within the drop-down menu as shown in the following screen shots:

Figure 14: Correlation Drop-Down Menu

- In the window above the Probable, Possible, w/o Pipe and Out of Bracket correlations maybe ticked to show or unticked to hide the correlation icons

Figure 15: Logger Noise Drop-Down Menu

- Shows the Logger Noise options Probable, Possible and No Leak, tick to display all the Loggers on the map or untick to hide any of the options
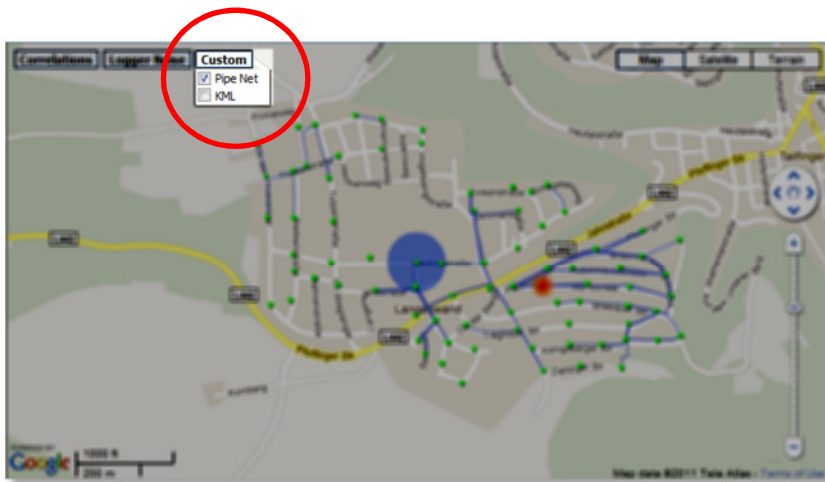

Figure 16: Logger Custom Drop-Down Menu

- Allows the user to select the pipe network created using the correlation wizard or KML (Keyhole Markup Language) layer provided by the water authority
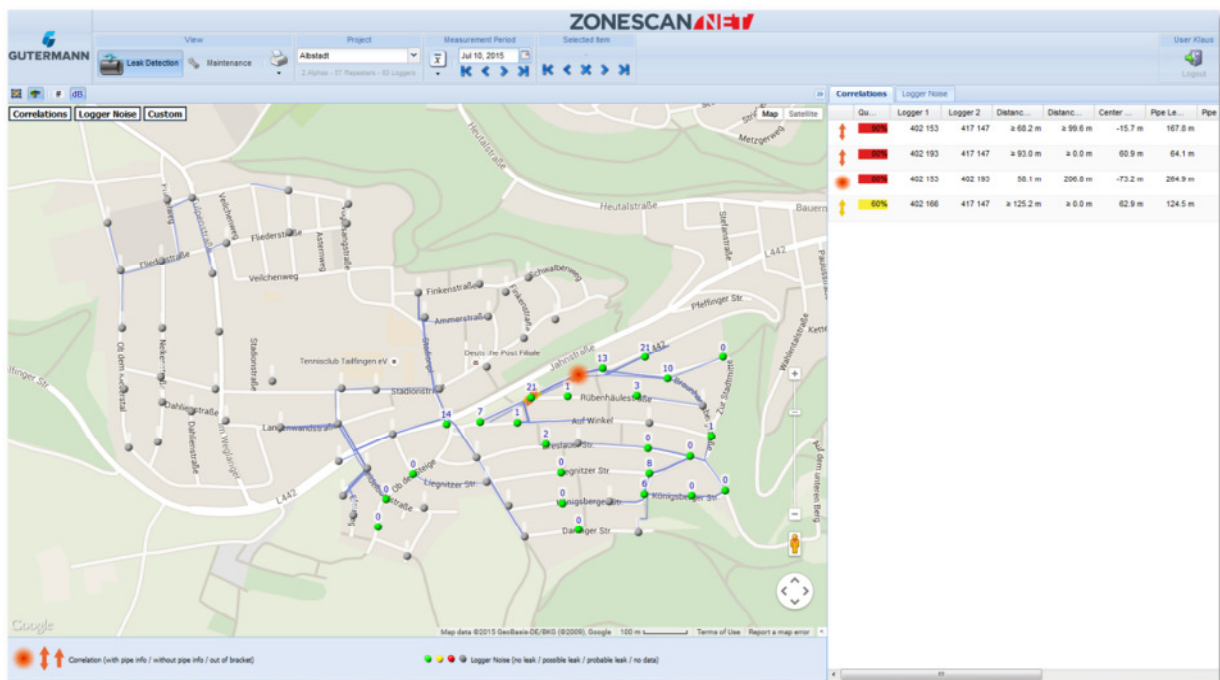
3.2 Correlations Table

Figure 17: Correlated Leaks

- The sorting of the tables can be changed at any time. Click the small arrow in the title field of the value that you would like to change. In the selection box that opens, you can sort in either alphabetical or reverse alphabetical orderThe columns can also be displayed or hidden from the table. To do this, click the small arrow in the title field. In the selection menu that appears, move the cursor to the Columns item. In the list that is now displayed, you can set a check mark in the field that you would like to display or remove the check mark from a field that you would like to hideClick the Correlated Leaks table to display all values in the list area that you have displayed in the map

3.2.1 Table Fields

Figure 18: Correlation Table Fields

Quality		Logger 1	Logger 2	Distance L1	Distance L2	Center Distance	Pipe Length	Pipe Setup	Comments
↕	40%	502995	502998	≥ 104.9 m	≥ 13.4 m	45.8 m	118.4 m	⊖ ▾	
●	100%	502996	502997	51.1 m	18.0 m	16.5 m	69.1 m	✓ ▾	
●	80%	502982	502983	30.1 m	22.0 m	4.0 m	52.1 m	✓ ▾	
●	100%	502987	502988	28.0 m	42.3 m	-7.2 m	70.3 m	✓ ▾	
●	50%	502726	502975	29.0 m	83.0 m	-27.0 m	112.0 m	✓ ▾	
●	40%	502726	502972	12.2 m	88.3 m	-38.0 m	100.5 m	✓ ▾	
↕	40%	502975	502994	≥ 0.0 m	≥ 103.1 m	-54.0 m	98.1 m	⊖ ▾	
●	50%	502983	502994	17.2 m	122.8 m	-52.8 m	140.0 m	✓ ▾	
●	100%	502982	502994	34.2 m	157.9 m	-61.8 m	192.1 m	✓ ▾	
●	50%	502972	502982	322.5 m	180.0 m	61.3 m	502.5 m	✓ ▾	

Quality

A statement on the Quality of the correlation graph is made. The assessment ranges from 0 - 100%. The settings for the display of a possible or probable leak are made under Administration in Settings

Logger 1

Reference number of the first Logger that was correlated

Logger 2

Reference number of the second Logger that was correlated

Distance L1

Distance L1 specifies the distance between Logger 1 and the noise source. When the pipe material or a straight section of pipe is between L1 and L2 then a numerical value will be shown. If there is a bend in the pipe then a greater > sign will be given next to the value

Distance L2

Distance L2 specifies the distance between Logger 2 and the noise source. When the pipe material or a straight section of pipe is between L1 and L2 then a numerical value will be shown. If there is a bend in the pipe then a greater > sign will be given next to the value

Center Distance

If there is a correlation with no pipe data it's not possible to calculate the leak location especially without the pipe length. Using the sound velocity of the defined pipe material enables us to calculate the Distance of the leak from the middle of the pipe section between the 2 loggers. If there is a negative value (e.g. -67.4m) then the noise source is left of center in the direction of Logger 1. A positive value means the noise source is right of center and in the direction of logger 2

Pipe Length	This is the total Pipe Length between Logger 1 and Logger 2
Pipe Setup	Located in the Pipe Setup field are red, yellow or green indicators

Red indicators indicate that no pipe settings have been entered yet and the used data were taken over from the default values

Yellow images appear if manual settings were made and not all details are known (pipe length, diameter and material are known). With manual settings, the course of the pipe cannot be changed, unlike with the Pipe Wizard

Green indicators mean that all details are known for the settings and were taken over in full from the Pipe Wizard

To enter the pipe settings, use the mouse to click the small triangles, next to Comments, in the field that you would like to change. In the menu that appears, select "Manual Pipe Data Entry" if you would like to enter the data "manually" or "Start Pipe Wizard" if the data are to be determined automatically. To delete existing pipe data, select the "Delete Pipe Information" item
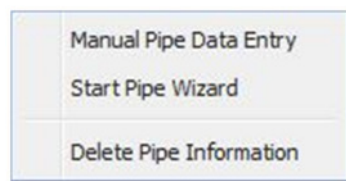

Figure 19: Entering pipe settings
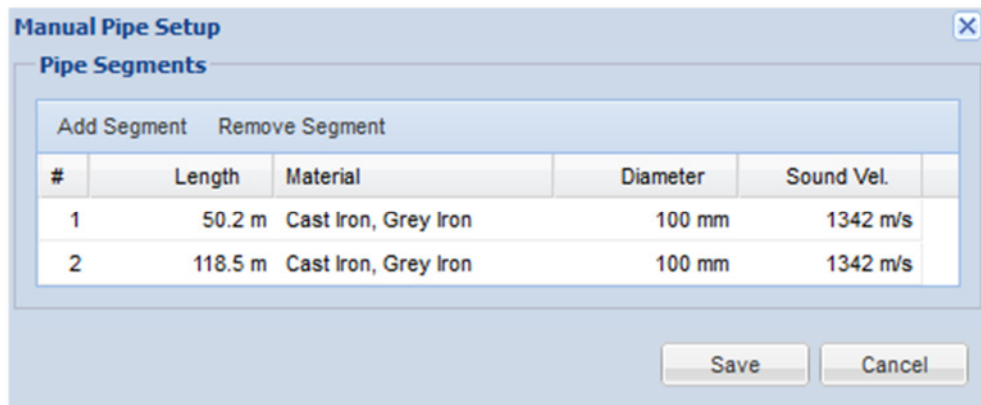
3.2.2 Entering Pipe Data Manually

Figure 20: Entering pipe settings – cont.

- Click the "Add Segment" button to enter a new pipe segment. Then complete the "Length, Material and Diameter" fields. The sound velocity is automatically calculated from your values and entered in the respective field. If you have more exact information on the sound velocity in this pipe segment, you may enter it manually in this field

- To apply the settings, click the "Save" button

- An already stored entry can be removed by clicking "Remove Segment; confirm removal by clicking "Save"

3.2.3 Entering Pipe Data with the Pipe Wizard

With the Pipe Wizard, data for the pipe settings are determined automatically via the pipe network and entered.

- First, you are requested – if necessary – to move the Logger to the correct position. To do this, click the Logger that you would like to move and drag it to the desired position. Repeat the process with both Loggers until they are correctly positioned. Use "Undo" to undo your last change

- The Logger 1 and Logger 2 fields indicate the respective, current positions of the Loggers

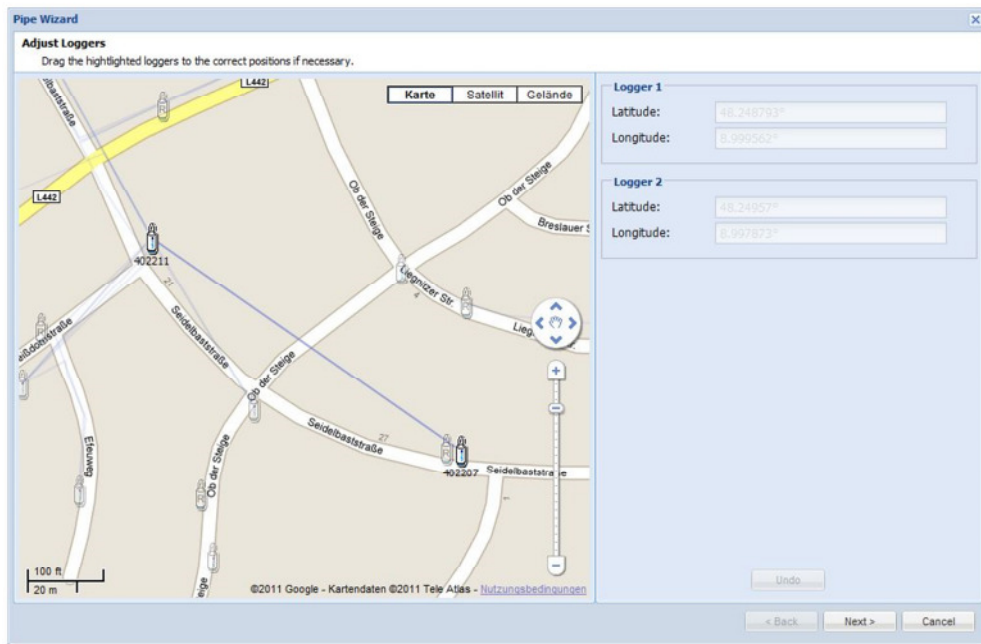- Once the Loggers are correctly positioned, click "Next"

Figure 21: Adjusting loggers

- In the next step, you have the option of changing the course of the pipeline. To do this, click the small box in the middle of the pipe that you would like to move. With the mouse pressed down, drag the pipe to the desired position

- You can now repeat this with the individual segments until the pipeline is correctly positioned. Use "Undo" to undo your last change. Displayed in the Pipeline Properties box are the current number of segments and the current pipe length
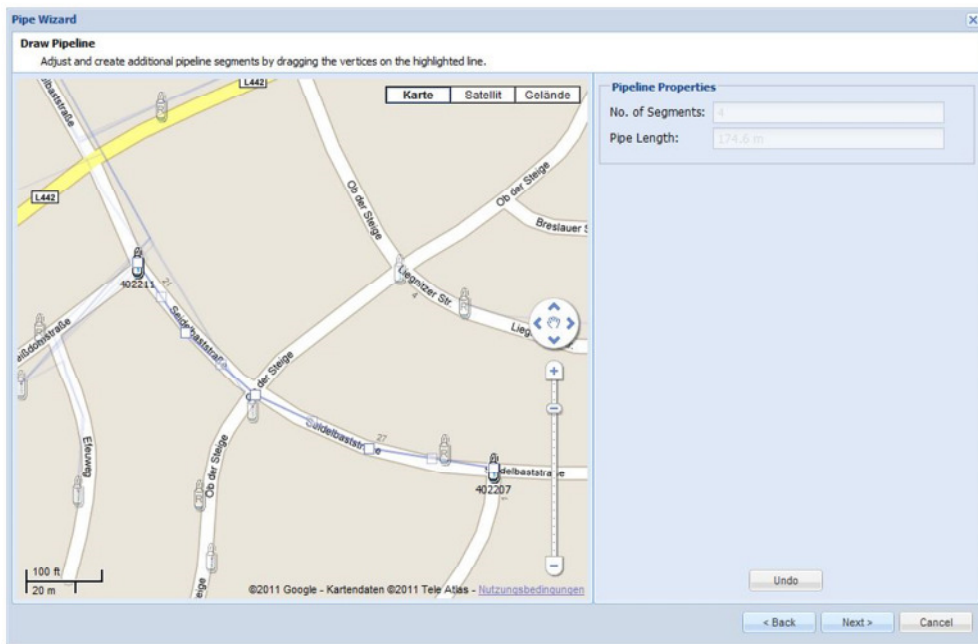
- After adjusting the course of the pipeline, click "Next"

Figure 22: Adjusting the pipeline

- Next, you are prompted to edit the properties of the individual segments of the pipeline. Complete the "Length, Material and Diameter" fields

    Note! If the data – Length, Material and Diameter – are contained in a displayed KML (Keyhole Markup Language) layer, it can be displayed in the map by clicking the corresponding pipeline. The values can be taken over 1:1 from the pop-up window that opens

- The Sound Velocity is automatically calculated from your values and entered in the respective field. If you have more exact information on the Sound Velocity in this pipe segment, you may enter it manually in this field

- After all fields are filled, click the "Finish" button to start the calculation. The calculated values are stored automatically
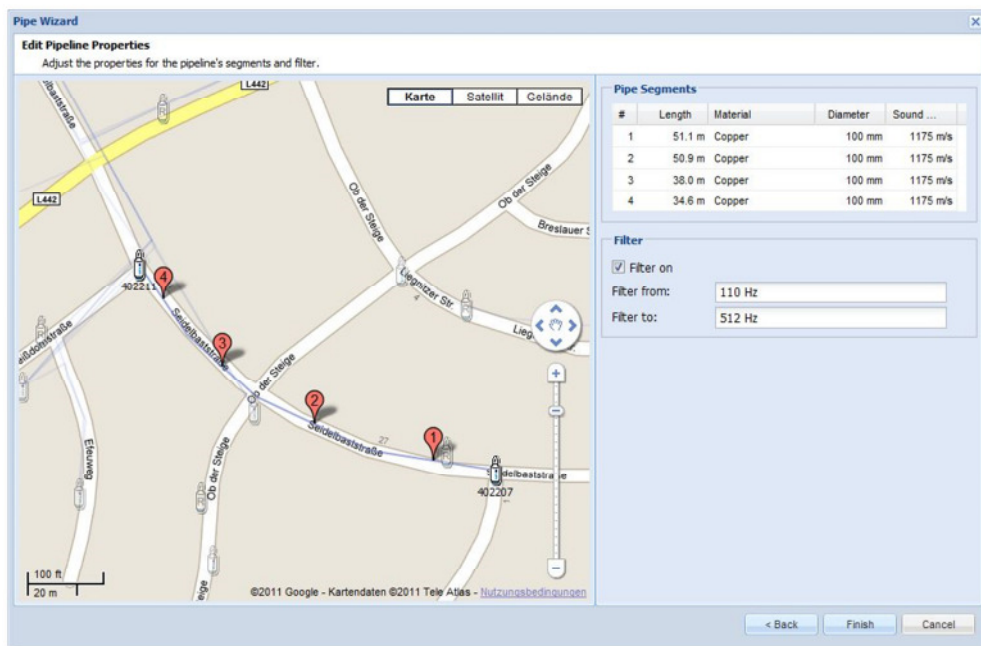
Figure 23: Adjusting the pipeline – Finish

Note! It is possible that the Pipe Wizard calculation cannot be performed immediately. It depends on the complexity of the recalculations and the workload of the server

3.2.4 Correlation Context Menu

- A context menu can be displayed for each individual, correlated leak. To do this, select the value in the table that you would like to visualize

- Right-click to open the context menu. Here, you can select the type of graph to be displayed. In addition, you can insert a comment

- The same menu can be opened by right-clicking a Correlation on the map
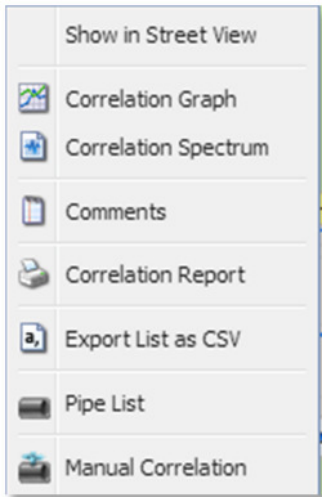
Figure 24: Context menu for correlations

Show in Street View   The map will switch to *Google Street View* and automatically zoom in on the chosen correlated point. See previous section on *Google Street View*

Figure 25: Google Street View of correlated leaks
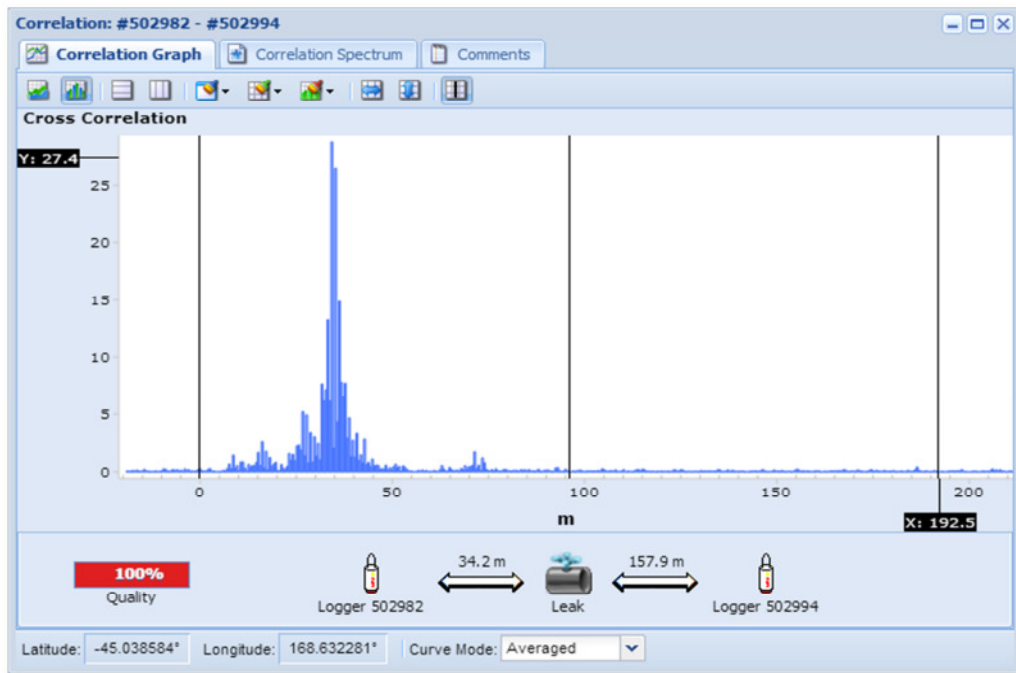
3.2.5 Correlation Graph

Figure 26: Correlation Graph

Correlation is a mathematical method for comparing two time synchronized signals with one another.

A leakage noise is simultaneously recorded by two sensors at different locations which are represented by the black lines at either side of the graph if the pipe data is known. The sound emitted by the leak spreads in the water pipe at a defined sound velocity. If the acoustic event were to be brief and occur only once, e.g., a blow with hammer, it would be simple to measure the arrival at both receivers. In this case, one would only need to compare the arrival times at the two receivers with one another. If these are the same, the sound has traveled the same distance to the receivers, i.e., the sound source lies in the middle of the pipe between the receivers.

If the arrival times are different, it is possible to calculate the distance to the two receivers from the measured time difference. The sound arrives at the closer sensor before the more distant sensor.

In the context of leakage noises, the goal of the correlation measurement is primarily to determine the propagation time difference of two signals.

Because the correlation curve also includes spectral information, it is often of interest to define the character of the leakage noise, particularly for distinguishing noises that are not related to the leak, provided this can be detected by means of a frequency analysis (e.g., electrical noise). The correlation curve can also be mathematically filtered for the purpose of

retroactively separating such interfering noise to better identify the correlation maximum caused by the leak.
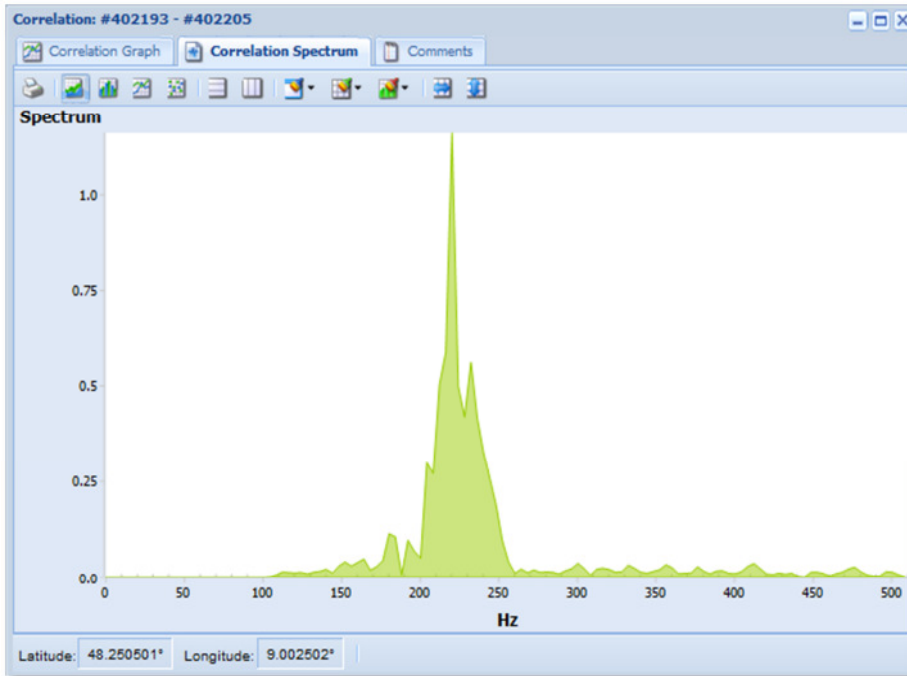
3.2.6 Correlation Spectrum

Figure 27 Correlation Spectrum

The correlation spectrum is a combination of the signal spectra of the two sensors, which is used for the correlation on the pipeline between the two sensors. In these common spectra, it may be possible to identify the influence of noises not related to the leak (e.g., electrical noise or pumps) on the correlation result (see also 3.2.4 Correlation Context Menu).

3.2.7 Correlation Report

Choose the required options by ticking the box opposite and then click open. A new window will open in the browser with the relevant maps and graphs associated with the chosen correlation.
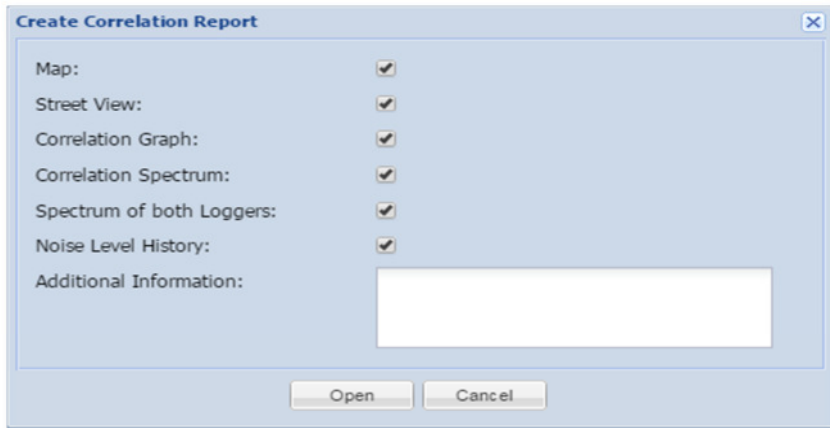
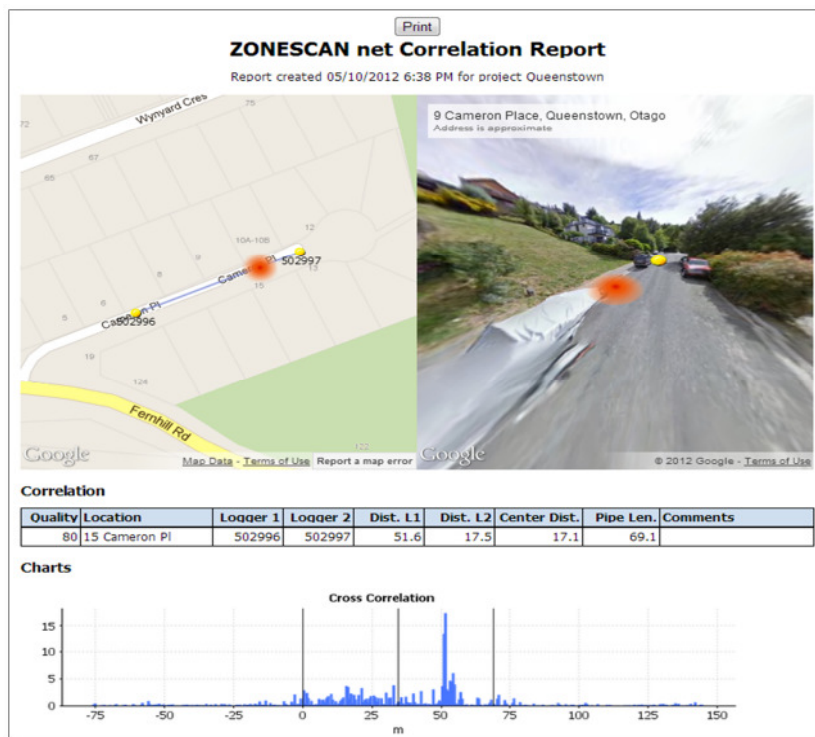

Figure 28: Correlation Report Options
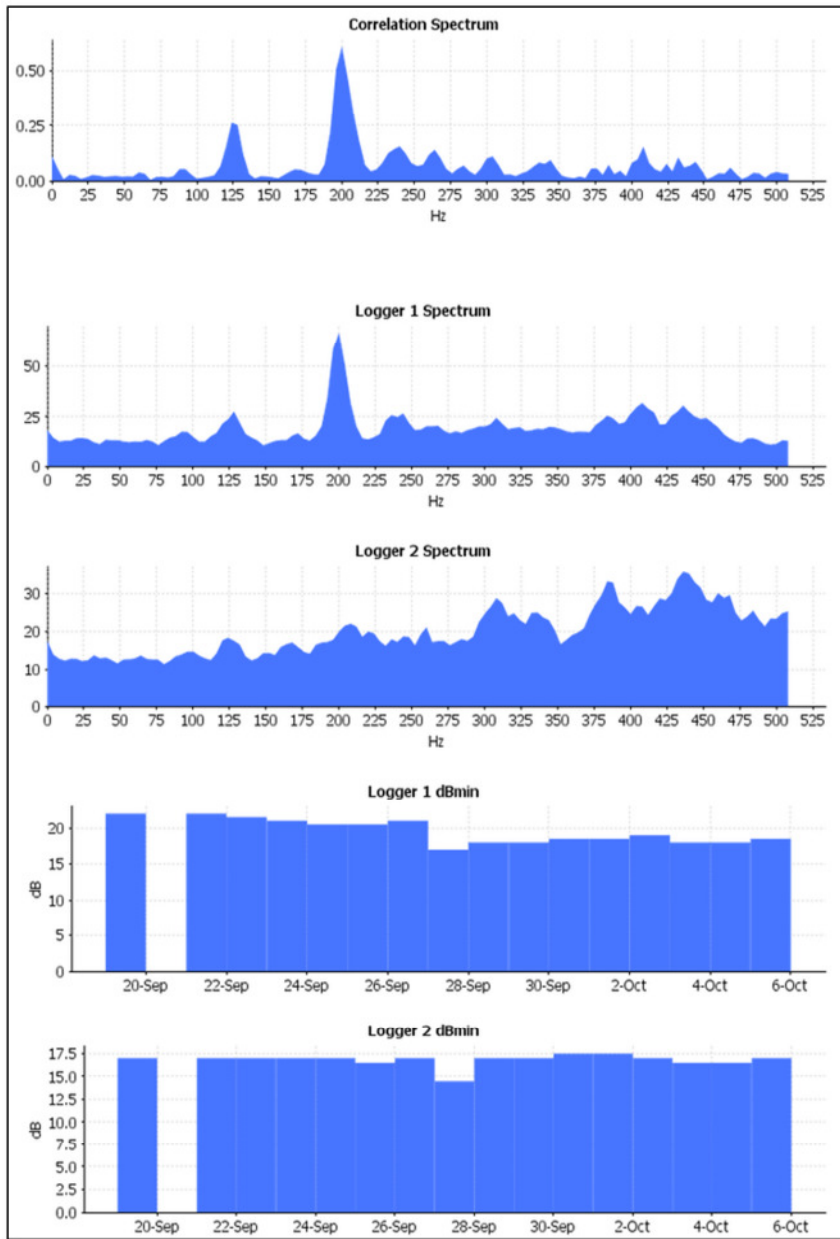

Figure 29: Correlation Report – Part 1

Figure 30: Correlation Report – Part 2

3.3 Logger Noise Table

Displayed in the Logger Noise Table are all values that are needed for an evaluation.

	Leak Score	Logger	Min. Noise	Location	Comments ▾
●	2	402 140	10 dB	Stadionstraße 112	Test Strom Plastikplättchen
●	54	417 147	31 dB	Pfeffinger Straße 135	Logger runtergefallen?
●	0	402 210	2 dB	Königsberger Straße 55	High Leak Score and dB
●	21	402 145	32 dB	Stadionstraße 73	E - Station
●	35	402 153	22 dB	Pfeffinger Straße 125	Elektrisch
●	13	402 148	12 dB	Vogelsangstraße 46	BHKW
●	7	402 175	35 dB	Finkenstraße 34	AW RB Finkenstraße 32-38
●	3	400 232	7 dB	Langenwandstraße 20	
●	0	400 233	4 dB	Stadionstraße 127	
●	0	402 138	0 dB	Dahlienstraße 8	
●	0	402 139	0 dB	Nelkenstraße 29	
●	25	402 141	15 dB	Fliederstraße 66	
●	0	402 142	0 dB	Ammerstraße 20	
●	2	402 143	4 dB	Nelkenstraße 17	

Figure 31: Logger Noise Table

3.3.1 Table Fields

Leak Score

The Leak Score is specified in a range from 0 to 100. The higher the number, the greater the probability that measurements will actually detect a leak.

The goal of the noise measurement with Loggers is to obtain as reliable a statement as possible regarding the presence of a leak at a specific point of the monitored water network. For the greatest reliability with respect to the presence of even small leaks, all information that is indicative of a leak near a Logger should be included. Misinterpretations should be avoided in this process.

The measurement values obtained from the histogram (see 3.2.4 Correlation Context Menu) – particularly the lowest ascertained sound-level value dBmin – which are a strong general indicator of a leak, are included in the subsequent processing.

In addition to the described histogram evaluation, the Leak Score includes, above all, knowledge from the frequency response

(spectrum). These values are used, in particular, for removing background noise.

The frequency spectrum data enables the algorithm to differentiate between leak noise and mechanical noises.

In addition, if there is a correlation at the same position near the logger for more than one day, this will also increase the leak score.

The result is output as the Leak Score in a range from 0 to 100. The settings for the display of a possible or probable leak are made under Administration in Settings

Logger	Reference number of the displayed Logger
Location	The Location field is a text field in which the location of the Logger, e.g., the street and street number, can be entered
Min. Noise	The smallest dB value measured during the last measurement.
Comments	Comments is a text field with entries on, e.g., permanent noise sources

3.3.2 Logger Noise Context Menu

A context menu can be displayed for each Logger. To do this, select the Logger in the table that you would like to visualize. Right-click to open the context menu. Here, you can select the type of menu that is displayed. In addition, you can insert a comment. The same menu can be opened by right-clicking a Logger on the map.
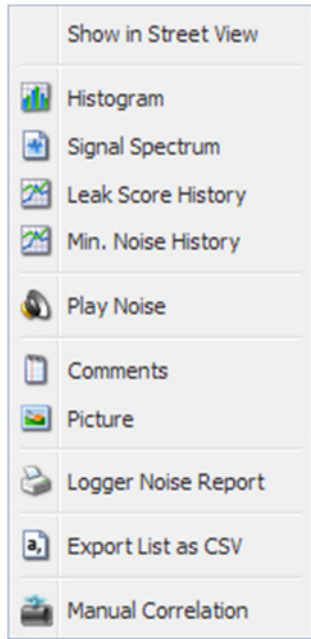

Figure 32: Graphical choices for leak score

Show in Street View   The Map will switch to *Google Street View* and automatically zoom in on the chosen logger. See section 3.1.2 *Google Maps Area*
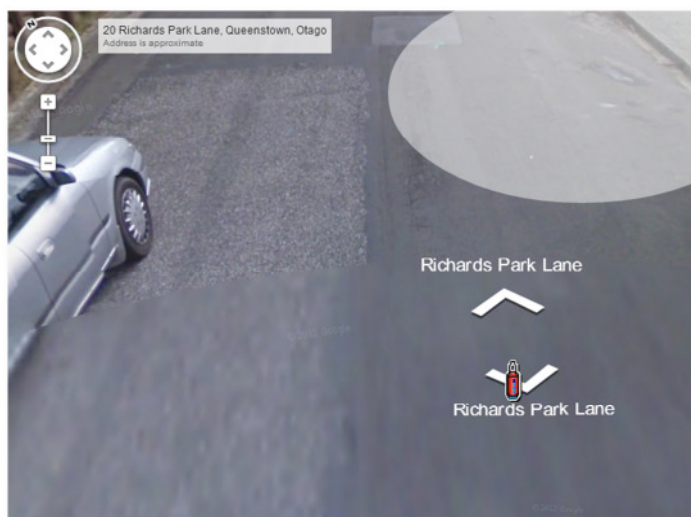

Figure 33: Google Street View shows chosen logger

Histogram

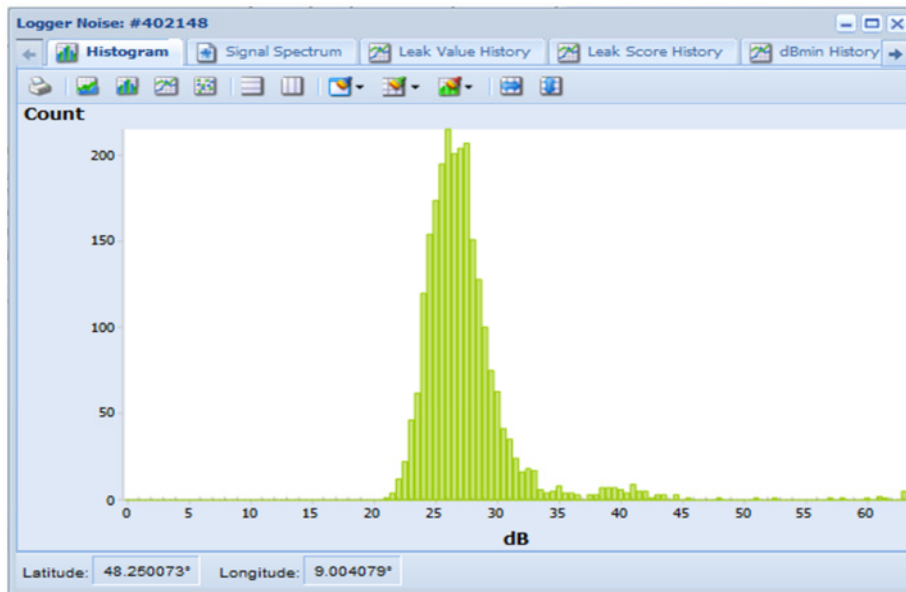The histogram is the graphical display of a noise distribution of the measured sound level

Figure 34: Logger Histogram

Histogram cont.

During noise monitoring, the noise level is repeatedly measured in intervals of a few seconds. During a one-hour measurement period (e.g., from 2 a.m. to 3 a.m.), several hundred individual measurement values are collected. The sound level is measured in dB. If, for example, the sound intensity of 15 dB is measured 120 times, this sound intensity has a frequency value of 120. Other sound intensity values are measured with a different frequency. If all of these frequencies are plotted as y values against a scale of the various dB sound intensities (x axis), one obtains the so-called histogram as a frequency distribution.

This histogram is a representation of the noise distribution in the measured period of time. The curve has a maximum, which represents the most frequently measured noise sound intensity.

For leakage noise monitoring, the quietest noise detected in the observed period is of particular interest. It is the smallest dB value for which a measurement value exists. Because a leakage noise is always present, one assumes that this value most likely characterizes the leakage noise, while higher dB sound intensity values arise from the addition of primarily random noise sources (e.g., vehicle traffic).

The so-determined smallest sound intensity value, found at the left edge of the histogram curve, is referred to as the dBmin value and plays a key role in the evaluation of the leakage noise

Signal spectrum

The signal spectrum can be used to make a statement about a possible leak.

Figure 36 shows a spectrum with electrical influence. If the curve has this appearance, one can assume that no leakage noise is present
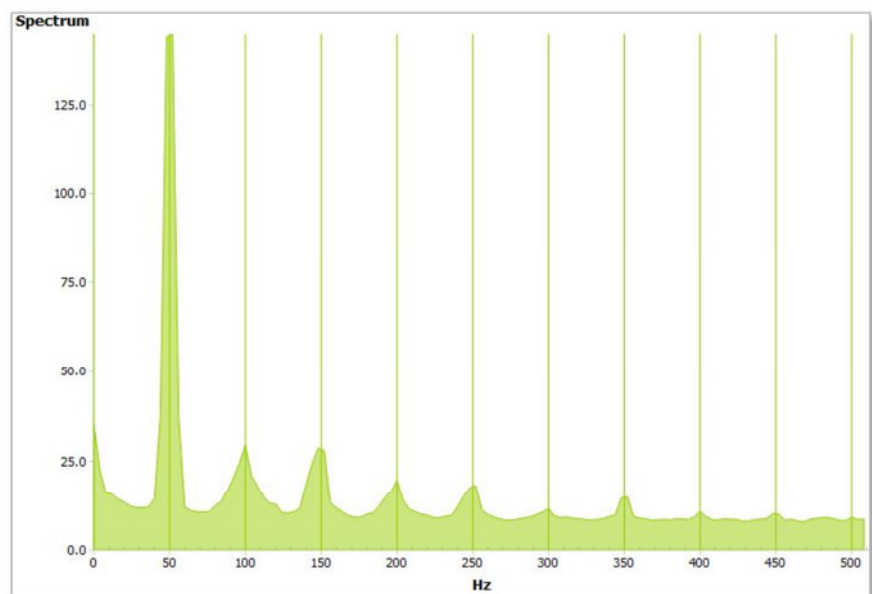

Figure 35: Spectrum with electrical influence

In figure 37, you see a typical spectrum of a leakage noise. It is clearly seen that the curve differs from that of a spectrum with electrical influence. If the graph has an appearance similar to that shown in figure 37, one can assume a leakage noise
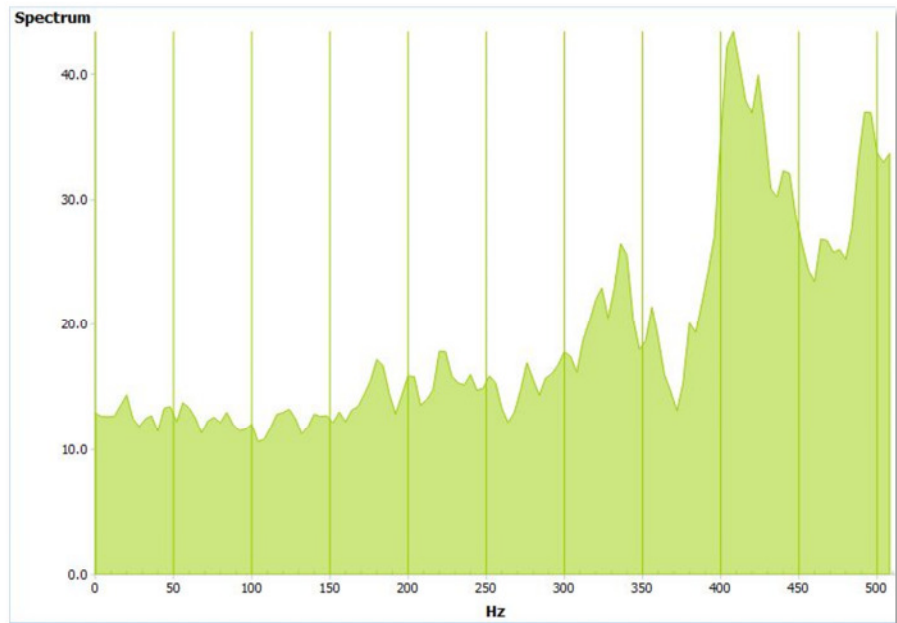

Figure 36: Spectrum with leakage noise

Leak Score History

The Leak Score History visualizes the historical values from the last 30 days, 3 months, 6 months, 12 months, 2 years or full history as long as the data is available for the time span. If the data available is less than a chosen period then the software will adjust the window to fit. On days with sound signal, the leak score is shown in blue, otherwise in green. In the example below, the leak score on days with sound signal is lower because the spectrum calculated from the sound signal is not typical of a leak.
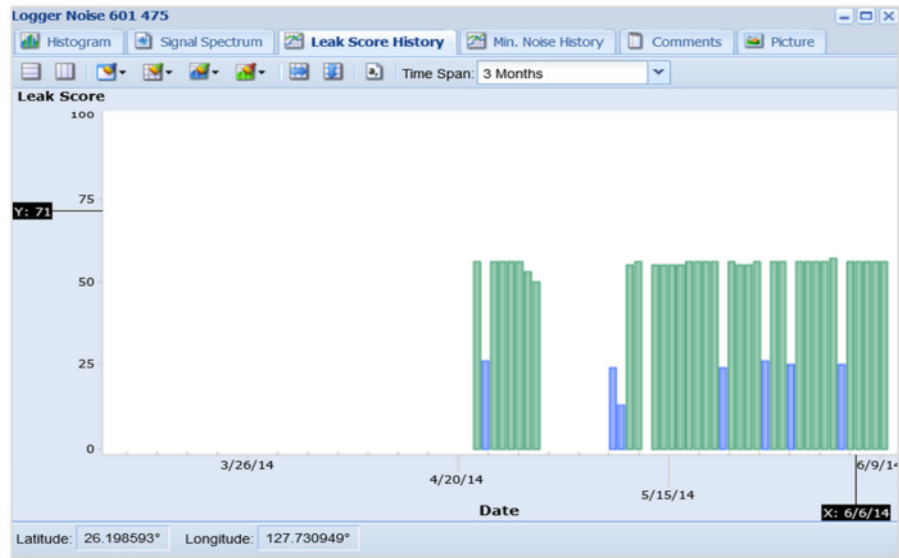

Figure 37: Logger Leak Score History

Min Noise History

The dBmin History visualizes the historical values from the last 30 days, 3 months, 6 months, 12 Months, 2 years or full history if data is available
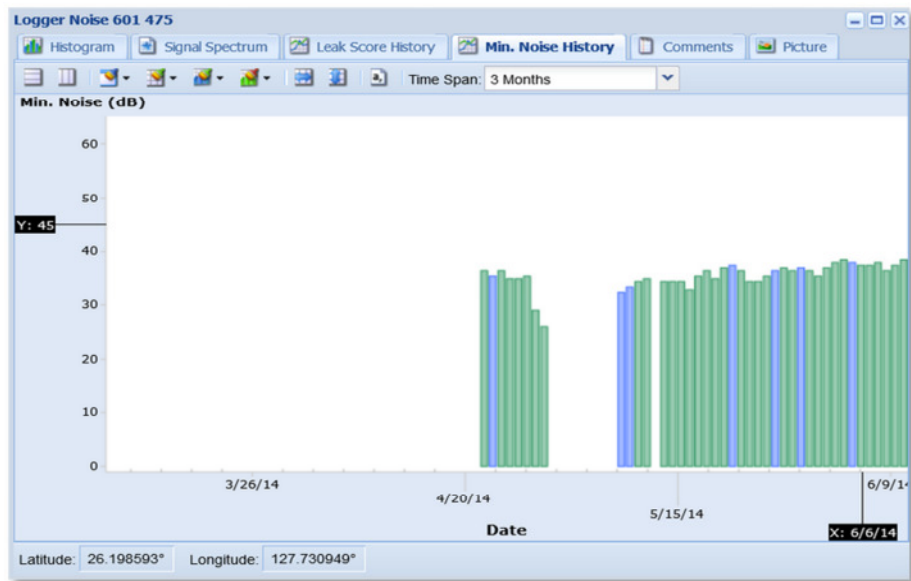
Figure 38: Logger dBmin History

Play Noise

The actual leak noise sample can be played through the PC speakers or headphones to help identify the type of sound recorded by the chosen logger. To help distinguish between background sound and leak sound compare a logger which has a leak score of 0 (zero) and then listen to a logger with a high leak score

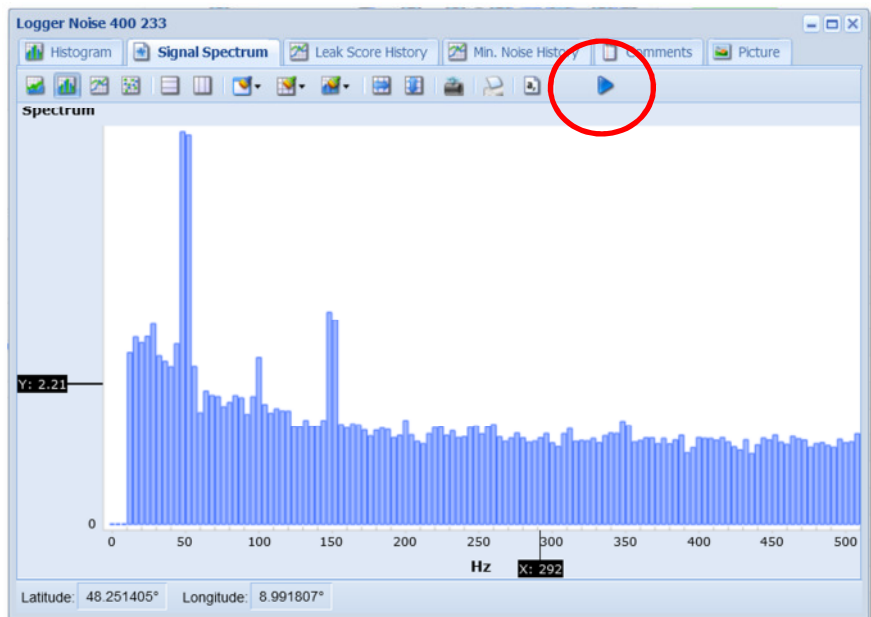- Depending on your browser, either click the Signal Spectrum and choose the Download Sound File or press the "Play" button.

Figure 39: Download Sound File