MODEL LD-7

Water Leak Detector

OPERATING INSTRUCTIONS AND USER MANUAL

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Section II

Components, Standard Accessories & Optional Accessories

The LD-7 consists of the following component items and standard accessories:

1. Ground microphone with three (3) pronged base and forty (40) inch long sensor cable

2. Amplifier with power/volume switch, mute switch, night lamp, battery low-power light (in the power switch light) and fixed low and high frequency filters.

3. Stereo headphones

4. Magnet base accessory

5. Three (3) section contact rod accessory

6. Durable, water-tight carrying case with custom foam interior

7. Instruction Manual

Section III.
Specific Operating Instructions

Assembly and Set-up

Figure 3-1 Amplifier Connectors and Controls

Figure 3-1 shows the amplifier:

1. On/off volume knob (and lamp "on" switch).
2. Mute switch.
3. Headphones jack receptacle.
4. Power ON light and low battery power check light.
5. Night illumination lamp.

Install the headphones plug connector into the headphones jack on the amplifier. Note: the headphones receptacle is power "switched", such that the headphones must be attached in order for the amplifier's power to turn ON.

Battery Power and Check Light

The low battery power check light (item 4 in Figure 3-1 above) is integral with the amplifier's power ON/OFF light. The check light will remain lit as long as the unit is turned ON and the batteries are in good condition. If the battery power is low, the light will flash on and off. Replace the batteries immediately or very soon.

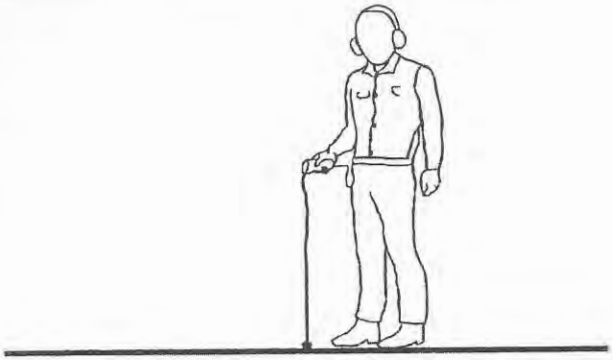


Figure 3-2 LD-7 with Ground Microphone

Mute Switch

Figure 3-2 shows the completely assembled LD-7 with the ground microphone positioned firmly on the street's surface directly over the water line. The mute switch on the amplifier shown in the user's hand is depressed only when the ground microphone and cables are completely stationary and the user is ready to hear the leak. Sound will not be heard until the mute switch button is depressed. The mute switch button must be released before moving the ground microphone in order to protect the user's hearing. The mute switch is specifically designed for this purpose.

Volume Control, ON/OFF Switch and Lamp Switch

Figure 3-1 shows the volume control knob on the amplifier. Turn the volume control knob clockwise to activate the unit and increase the sound level. Turn the volume control knob counter-clockwise to deactivate the unit or to decrease the sound level. Always adjust the volume control to a low level (10% to 25%) when first putting on the headphones and before depressing the mute switch. Increase the volume gradually until the water leak sounds can be heard easily but without distortion. Reduce the volume if there is distortion of the sound. If the control knob is depressed, the night illumination lamp turns ON.

High and Low Frequency Filters

The LD-7 has a preset low frequency filter set at 100 Hz and a high frequency filter set at 1000 Hz. This enables the unit to filter out all noises and sounds at 100 Hz frequency and lower and at 1000 Hz frequency and higher.

The 100 Hz low frequency filter and the 1000 Hz high frequency filter eliminate many extraneous noises such as traffic and wind.

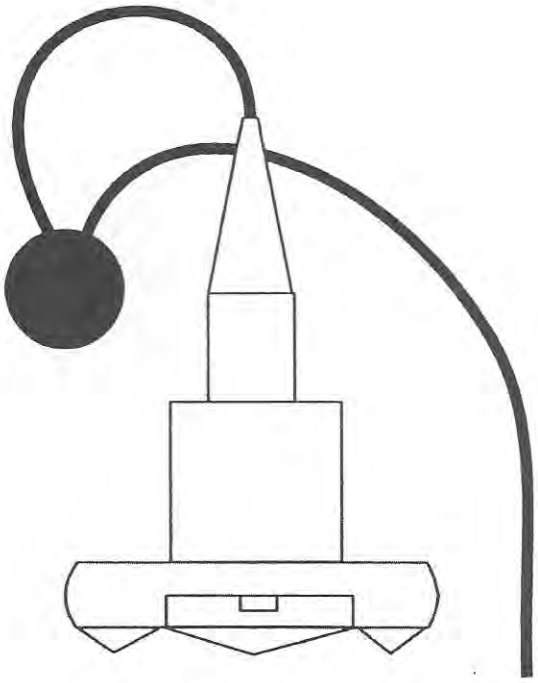


Figure 3-3 Ground Microphone for Streets

Ground Microphone Base for Streets

Figure 3-3 shows a side view of the ground microphone with the three (3) pronged base for listening on streets, pavement surfaces, or concrete slabs. The 3 prongs should rest firmly on the street's hard surface in order for sound to be transmitted clearly to the ground microphone's sensor.

Magnet Base for Hydrants and Valves

Figure 3-4 shows the magnet base attached to the ground microphone with the 3-pronged base. The magnet base can also be used without the 3- pronged base. To remove the 3-pronged base, simply unscrew the base from the sensor. The magnet base should only be hand-tightened onto the brass screw thread of the ground microphone. It should not be left loosely attached since this will create movement and slight noises.

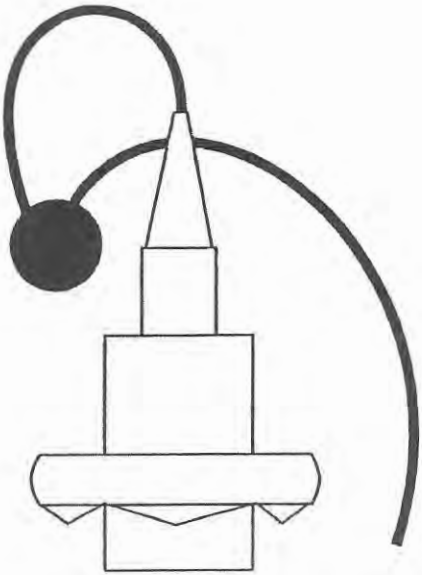


Figure 3-4 Magnet Base for Hydrants and Valves

With the magnet base attached, the user can attach the microphone to cast iron fire hydrants, water mains, iron valves, or steel water pipes and fittings. This will enable the user to hear the sounds being transmitted through the piping.

Contact Rod for Soil and Brass Valves

The contact rod is provided to assist in coupling the ground microphone to materials that are soft, spongey, porous, or non-ferrous. To use, attach the contact rod to the brass thread on the base of the ground microphone. If only a short rod is needed, attach only the pointed section of the contact rod to the bottom of the ground microphone. For deep brass valves at curb stops, use all three (3) sections of the contact rod, and push the point of the contact rod firmly against the brass valve. For water leak searches in areas covered by loose soil or grass cover over the water line, use only the pointed bottom section of the contact rod.

In either application, do not try to hold the ground microphone or the contact rod with your hand, since this will cause small movements and "crackling" sounds at the point of contact of the rod. Let the ground microphone or the contact rod rest against the curb box wall or the meter box wall. For water leak searches in areas covered by loose soil or grass, push the pointed contact rod firmly into the dirt two to six inches, but do not hammer it into the ground or try to force it in deeply. It only needs to make firm contact in the ground.

Section IV
General Strategies for Water Leak Detection

Types of Water Leak Sounds

There are three different, commonly identified sounds produced by water leaks:

1. Pipe resonance and vibration from orifice pressure reduction.

2. Water impaction on the surrounding soil.

3. Water circulation and flow in the surrounding soil cavity.

Resonance or pipe vibration is often the loudest or most intense leak noise, sounding like a "whoosh" or a "hiss." Water impaction and circulation are often weaker, and often may only be heard when the LD-7 user is very close to the leak or directly over it. Water impacting on the soil is a "beating" or a rapid "thumping" sound, and water flowing into the soil and around the pipe sounds like a "babbling brook" or a mountain stream. If the leak has created a very large cavity in the soil, these second and third sounds may not be heard at all.

Factors Affecting Leak Sounds

There are several factors that affect the loudness and the frequency range of sounds made by water leaks in subsurface pressurized water pipes and transmitted to the surface. These factors are:

1. Water pressure in the pipe (must be 15 psi or more)*
2. Pipe material and pipe diameter
3. Soil type and soil compaction
4. Depth of soil over the pipe
5. Surface cover: grass, loose soil, asphalt, concrete slab, etc.

* Pressuring to 50-60 psi or more will greatly aide detection. Use CO2 (where permitted by law) or other method to pressure the low-pressure lines when looking for a leak. Always use caution when pressuring lines.

The intensity or loudness of water leak sounds increases greatly with increasing water pressure (see Figure 4-1).

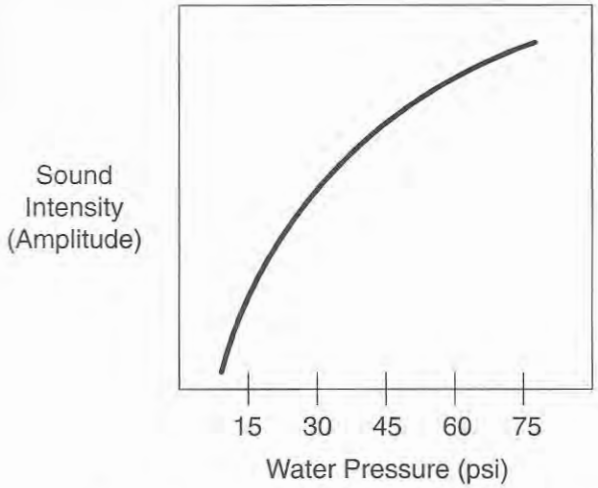


Figure 4-1 Sound Intensity vs. Pressure Graph

Metal pipes, such as iron mains, copper services, and steel pipes, produce water leak sounds that are louder and that are higher in frequencies than do PVC pipes or asbestos-cement pipes. Thus, knowledge of the pipe material is important (see Figure 4-2).

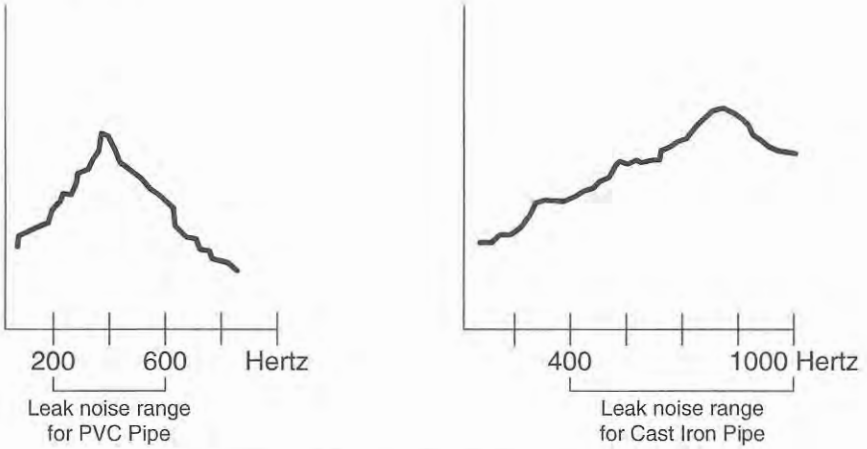


Figure 4-2 Filtered Frequencies Graphs

If the LD-7 user knows that the leak is small, with pressure of 60 psi or more, and in an iron main or copper service, then the user knows the sounds should be in a high frequency range, perhaps 400 Hz to 1200 Hz. If the LD-7 user knows that the leak is large, with a pressure of only 30 to 40 psi, and in a PVC pipe, then the user knows the sounds should be in a lower frequency range, perhaps 200 Hz to 600 Hz.

Large diameter pipes, whether they are PVC, concrete, steel, or iron, produce much less sound from water leaks and produce lower frequency sounds than small diameter pipes. Because of their mechanical properties, larger diameter iron and steel pipes, such as 24 inches diameter and greater, resonate with much lower frequency leak sounds than the smaller diameter iron and steel pipes, such as 6 inches and 8 inches. Extremely large concrete and steel pipes, such as 96 inches or more, make very little "orifice pressure reduction" sound at their water leaks.

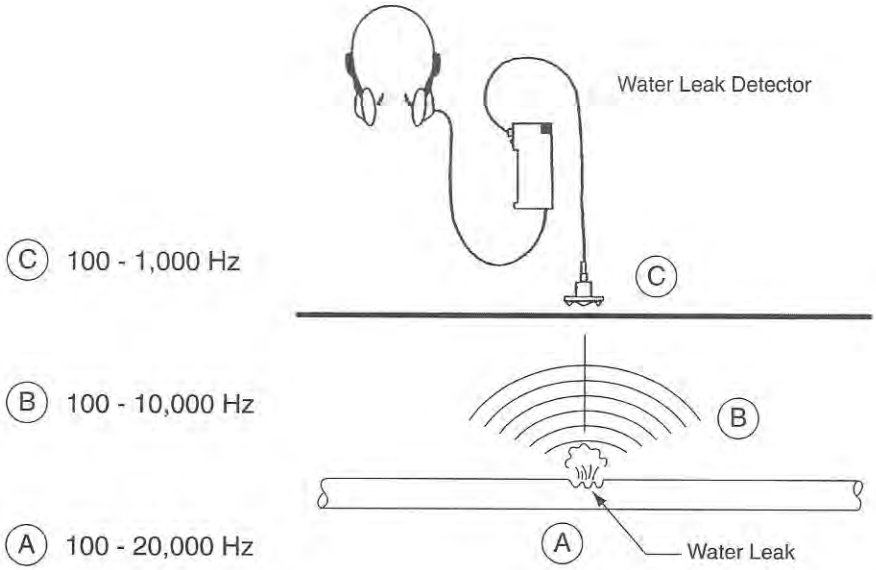


Figure 4-3 Absorption of Sound Frequencies by Soil

Sandy soil and very loose soils, particularly over a freshly buried pipe line, do not transmit the sounds of water leaks very well, nor do water saturated soils such as bogs and swamps. Hard, compacted soil transmits the sounds of water leaks best. Soil absorbs the sounds of water leaks very quickly, and it is very difficult to hear the sounds of water leaks from lines deeper than 7 or 8 feet. Leaks in water lines that are only 3 or 4 feet deep are much easier to hear at the ground's surface than leaks in deeper lines. The attenuation of sound in low frequencies in soil is approximately 40 dB for every 3 feet of depth. Also, the higher frequencies of sound are absorbed more quickly in soil than the low frequencies, as shown in Figure 4-3 and Figure 4-4.

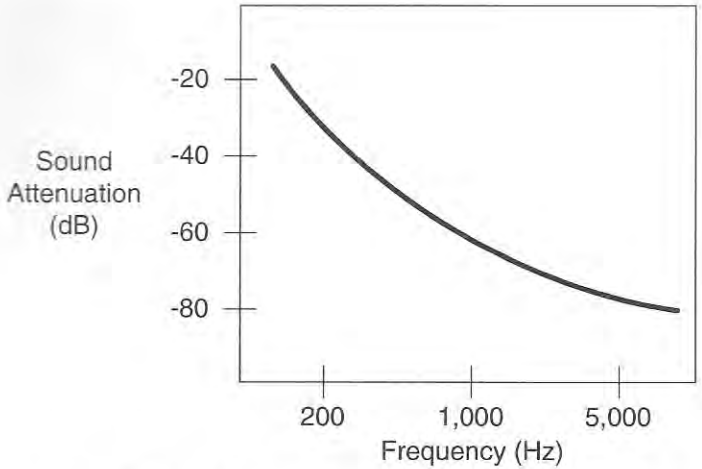
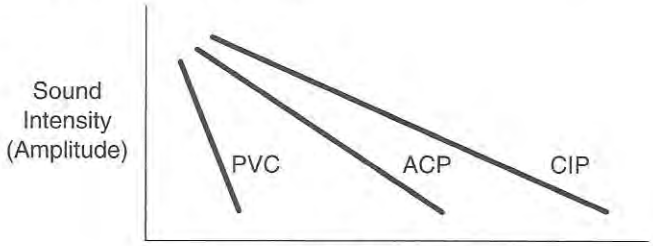


Figure 4-4 Sound Attenuation of Different Frequencies by 4 feet of Soil

Finally, the ground cover, whether it is an asphalt street, loose dirt, concrete slab, or grass lawn, also makes an important difference. Hard street surfaces and concrete slabs resonate with the sounds of the water leak, and the leak may be heard for 5 to 10 feet or more on either side of the water pipe. Grass lawns and loose dirt surfaces do not offer such a resonating plate-like surface.

Sound Transmission Through Pipe Walls

Metal pipes, particularly iron mains between 6 inches and 12 inches, copper services, and steel pipes, transmit the sounds of water leaks for hundreds of feet in every direction. Asbestos-cement pipe and PVC pipe do not transmit the sound nearly as far, and the sounds of leaks in these materials may be transmitted only 100 to 500 feet (see Figure 4-5).



Pipe Material	Transmitted Frequencies
Cast Iron	100 - 20,000 Hz
PVC	100 - 10,000 Hz

Figure 4-5 Sound Transmission vs. Distance from Leak

Distances transmitted for the sounds of water leaks are a function of the pipe diameter as well as the pipe material (see table below).

Pipe Material and Diameter	Typical Max. Distance for Transmission of Leak Sounds
6 inch Cast Iron Pipe	600 to 1000 feet
12 inch Cast Iron Pipe	400 to 800 feet
24 inch Cast Iron Pipe	200 to 400 feet
6 inch AC Pipe	400 to 800 feet
12 inch AC Pipe	300 to 500 feet
24 inch AC Pipe	100 to 300 feet
6 inch PVC Pipe	300 to 400 feet
12 inch PVC Pipe	200 to 300 feet
24 inch PVC Pipe	50 to 100 feet

Thus knowledge of the pipe material and diameter is important to knowing how far the sounds of a leak may be transmitted along the pipe walls, which determines the strategy for finding the leak. If the leak is in a 6 inch cast iron water line, the LD-7 user will listen first at the hydrants and main valves. If the LD-7 user hears nothing at the first location, he moves 500 to 600 feet to another hydrant or main valve. If the leak is in a 24 inch PVC pipe however, the LD-7 user cannot simply listen at only hydrants and main valves and be assured that there are no leaks within 500 to 600 feet. In this case, the LD-7 user must check at every possible curb stop and valve, or even ground mike the entire length of the 24 inch PVC pipe.

Water Leak Surveys

If there is no obvious evidence of a major water leak, like water surfacing or very loud leak sounds at the hydrants, but the area is experiencing abnormally large water losses, then a "water leak survey" may be needed. The water leak survey is usually done with only the magnet attached to the sensor, and it initially is conducted at the hydrants and main valves (see Figure 4-6).

Figure 4-6 Water Survey at Hydrant

As previously discussed, knowledge of the pipe material and pipe diameter is important in order to know whether a thorough survey can be performed only by listening at hydrants and valves that are 500 to 600 feet apart.

During the water leak survey, if the sounds of a possible water leak are heard at a hydrant or valve, the LD-7 user then checks at every immediate, nearby lateral valve, hydrant valve, and residential or commercial service line. At the valve or other location where the leak sound is the loudest is where the final leak "pinpointing" usually begins.

Water Leak Pinpointing

The "pinpointed" location refers to the exact spot on the street's surface directly above the water leak. This spot is almost always the location of the maximum intensity or maximum loudness of the leak sounds (see Figure 4-7).

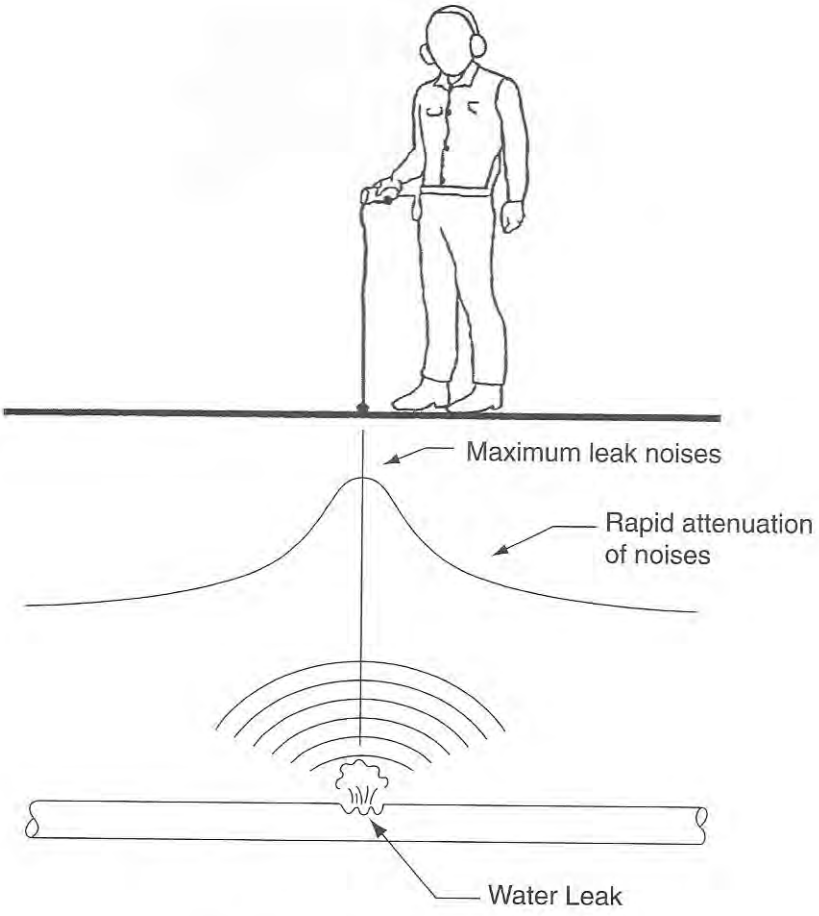


Figure 4-7 Water Leak Pinpointing

To find this spot, the LD-7 user must carefully mark the location of the water line on the street after locating it exactly with a pipe and cable locator. Usually, the piping between the valve or hydrant with the loudest sound and the valve or hydrant with the second loudest sound is the section of the line that needs to be marked. The section must be accurately located and marked on the street in order for the LD-7 user to consistently listen directly over the line.

The LD-7 user listens with the 3-pronged base attached to the ground microphone directly over the line. The LD-7 user moves the ground microphone 3 to 4 feet each time in the direction of the water line, listening and moving closer to the water leak. While the LD-7 user is moving, he does not adjust the volume control, since the volume must be constant.

Figure 4-8 Leak Surveying at a Meter

Dealing With Extraneous Noises

Often there are extraneous noises at a water leak job site, like traffic, wind, AC hum, etc., that can make leak detection difficult, particularly water leak pinpointing on the street.

Step 15 feet away from the water line to an area of the street pavement identical in surface to that street surface over the water line but without any water lines or other utilities anywhere beneath it. If it is windy, block the wind's flow around the sensor and cable with your body. Familiarize yourself with any extraneous noises that are present with the ground microphone on the street at this location away from the water line. Return to the water line and ignore all the extraneous noises and concentrate on the unique sounds that are present only over the water line.

This method is also very effective when the leak is very small, or very quiet, and the LD-7 user is not even certain that what he hears is the leak. In this situation, move 15 feet away from the water line and listen. If you hear the same sounds as before, then you were not hearing the sounds of a water leak.

Section V
Specifications

Amplifier

Input Impedance	:	430k ohm +/- 1%
Output Impedance	:	4-10 ohm
Amplification	:	56 dB +/- 3%
Frequency Range	:	100Hz to 1000Hz
Power	:	2 AA dry cell batteries (1.5 V x 2)
Power Consumption	:	20 mA Nominal (30-hour life)
Weight	:	.507 lb. (230 gm)
Size	:	5.7" x 1.25" x 3" (145mm x 30mm x 68mm)

Ground Microphone

Sensitivity	:	1.0 V/G (400Hz)

Headphones

Impedance	:	20 ohms (mini-stereo headphones)

ABS Carrying Case

Weight (full)	:	5.84 lb. (2.65 Kg)
Size	:	14" x 10" x 6" (356mm x 254mm x 152mm)

Section VI
Warranty Statement

SubSurface Leak Detection, Inc. (SubSurface) warrants each product of its manufacture to be free from defects in material and workmanship subject to the following terms and conditions. The warranty is effective for twelve months after shipment by SubSurface to the original purchaser.

Our obligation under the warranty is limited to servicing or adjusting any product returned to the factory for this purpose and to replace any defective part thereof. Such product must be returned by the original purchaser, transportation charges prepaid, with proof in writing, to our satisfaction, of the defect. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. Prior to repair in this instance, a cost estimate will be submitted. Service or shipping information will be furnished upon notification of the difficulty encountered. Model and serial numbers must be supplied by user. Batteries are specifically excluded under the warranty.

SubSurface shall not be liable for any injury to persons, or property, or for any other special or consequential damages sustained, or expenses incurred by reason of the use of any SubSurface product.

Returns for Repair and Replacement Parts

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