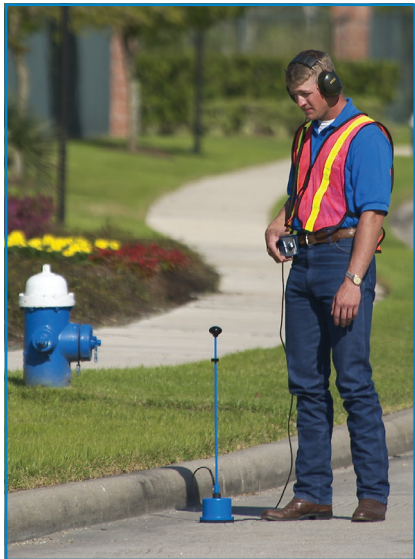
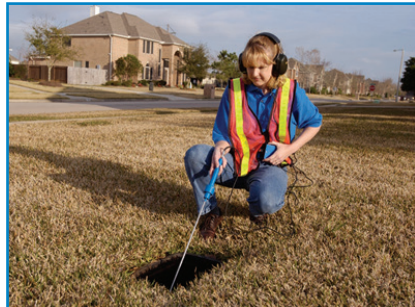


# AQUA-SCOPE®

## User Manual



## **Proprietary Notice**

*The contents of this manual are proprietary to Heath Consultants Incorporated. Reproduction of this manual, in whole or in part, is prohibited without the express written consent of Heath Consultants Incorporated.*

*Heath Consultants Incorporated operates under a continual product improvement program and reserves the right to make improvements and/or changes without prior notification.*

*This manual supersedes all previous manuals for the Heath Aqua-Scope.*

**HPN 2913769**  
**Revision B**

# **AQUA-SCOPE®**

## **User Manual**

---

Heath Consultants Incorporated  
Houston, TX  
713-844-1300  
Fax: 713-844-1309

**1-800-HEATH-US**  
**[www.heathus.com](http://www.heathus.com)**



*Heath....Safety, Leadership, Innovation, Performance  
Then, Now and Tomorrow*

## **INTRODUCTION**

Economy and hygiene demand the most expedient way to locate and repair water pipeline damage. More extensive water leaks can also result in considerable danger to traffic by causing street flooding.

The best method to locate and pinpoint leaks in water pipelines is by means of electro-acoustical detection. The sounds made by water escaping from a water leak spread as spherical background waves in the ground. The sounds are also transmitted by the (metallic) pipeline itself. The use of suitable detecting devices enables us to determine the exact location of a leak by listening to the escaping water from a small hole in the water pipeline. The sounds made from such leaks provide a good condition for electro-acoustical water leak detection.

## **FUNCTION**

The Heath Consultants Incorporated AQUA-SCOPE<sup>®</sup> System is an advanced state-of-the-art electro-acoustical water leak locator designed to provide the operator with the means for efficient locating and pinpointing of water pipeline leaks.

The instrument amplifier/receiver unit provides a wide range of clarity, simplicity, and ease of control. The ground and hand microphones have good wind immunity for outdoor use. A removable handle and extension rods are handy for compact storage.

# TABLE OF CONTENTS

INTRODUCTION.....	1
FUNCTION .....	1
TABLE OF CONTENTS .....	2

## CHAPTER I

### **I. AQUA-SCOPE SYSTEM, COMPLETE:**

AQUA-SCOPE Basic System (Figure 1) .....	4
--	---

### **II. AQUA-SCOPE SYSTEM, COMPLETE W/OPTIONAL ACCESSORIES:**

AQUA-SCOPE System with Optional Accessories (Figure 2) .....	5
--	---

A. Amplifier Module (Figure 3) .....	6
B. Ground Microphone (Figure 4) .....	7
C. Direct Contact Microphone (Figure 5).....	9
D. Headphones (Figure 6) .....	10
E. Meter Module (Figure 7) .....	11
F. Resonant Plate (Figure 8) .....	12
G. Plunger Bar (Figure 9) .....	13

## CHAPTER TWO

### **III. PRINCIPLES OF SOUND:**

A. Engineering References .....	14
B. Relating Sound Principles to Leakage Detection .....	17

## **CHAPTER THREE**

### **IV. AQUA-SCOPE OPERATION:**

A.	Application .....	19
B.	Leakage Detection with the Direct Contact Microphone .....	19
C.	Pinpointing with the Ground Microphone .....	22
D.	Exercises with the Direct Contact/Ground Microphones .....	25
E.	Graphical and Numerical Determination of the Point of Leakage .....	26
F.	Practical Examples .....	29
G.	Alternate Methods of Leakage Detection .....	31

## **CHAPTER FOUR**

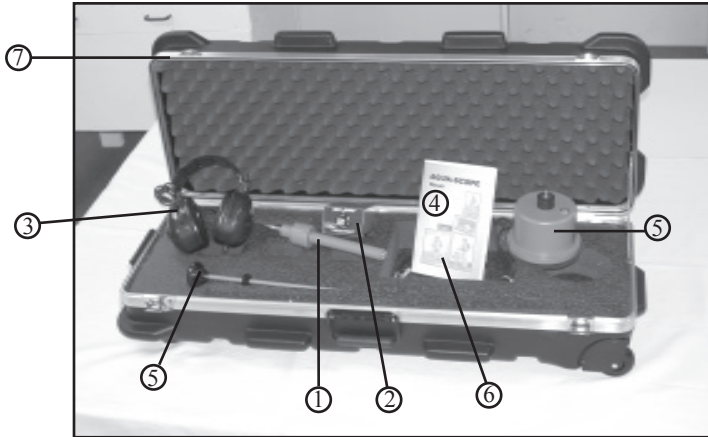
### **V. SERVICE INFORMATION:**

A.	Warranty and Warranty Repair .....	33
----	------------------------------------	----

Customer Assistance, Manufacturing and Service Locations .....	Back Cover
---	------------

# CHAPTER ONE

## I. AQUA-SCOPE SYSTEM, COMPLETE:

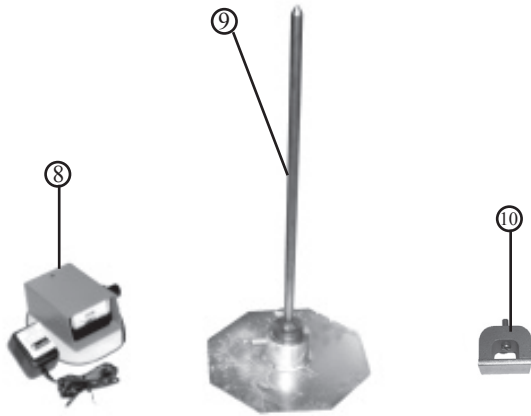


(Figure 1)

### AQUA-SCOPE Basic System (part No. 2903768)

- |   |  |
|---|--|
| 1. Direct Contact<br>Microphone w/ext<br>(Part No. 2916428) | 5. Ground Microphone<br>w/Handle<br>(Part No. 2916427) |
| 2. Amplifier Module<br>(Part No. 2916426)                   | 6. Microphone Cables (2)<br>(Part No. 2916411)         |
| 3. Headphones<br>(Part No. 2911352)                         | 7. Carrying Case<br>(Part No. 2913767)                 |
| 4. Instruction Manual<br>(Part No. 2913769)                 |  |

**II. AQUA-SCOPE SYSTEM, COMPLETE W/ OPTIONAL ACCESSORIES:**



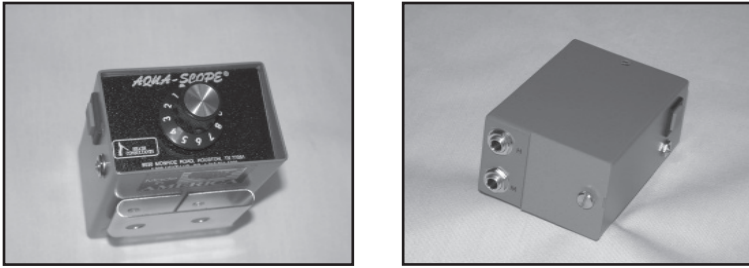
(Figure 2)

AQUA-SCOPE System with Optional Accessories

- |   |  |
|---|--|
| 8. Meter Module w/ Battery Charger (110 VAC) (Part No. 2923754)             | 12. Good Vibrations VHS Video Training Presentation (Not Shown) (Part No. 7106653) |
| 9. Resonant Plate with 18" Spike (Part No. 2921326)                         | 13. Meter Module w/ Battery Charger (220 VAC) (Not Shown) (Part No. 2923698)       |
| 10. Magnetic Tip used with The Direct Contact Microphone (Part No. 2923776) | 14. Ear Pad Cover used w/ Headset (Not Shown) (Part No. 2927414)                   |
| 11. Plunger Bar w/ Insulated Handle (Not Shown)                             |  |



## A. Amplifier Module (Part No. 2916426)



(Figure 3)

### 1. General Specifications:

Weight: 1.37 lbs. (620 grams) including batteries.

Size: 5" deep x 3.7" wide x .4" thick (12.7 x 9.40 x 6.096 cm) including all projecting knobs, clips, and jacks.

Batteries: Requires 2 alkaline 9-volt batteries. Eveready 522, Mallory MN1604 or any NEDA 1604A type is recommended.

Battery Life: Approximately 30 hours.

Amplifier

Gain: Approximately  $3 \times 10^5$  volts/volt maximum.

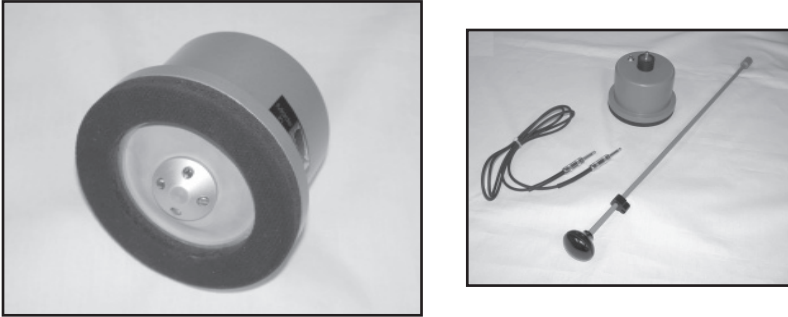
Storage

Temperature: Limited to the specifications on the batteries used.

Figure 3 depicts in two views the Amplifier Module with all hardware, in put/output jacks, and controls. Battery access is gained by removing the Battery Access Plate, exposing the two nine volt batteries, which power the instrument. The battery adjacent to the input jack should be removed first. The second battery may require lateral movement toward the input jack end to clear the opening. Replacement and insertion should be performed in the opposite sequence. Be careful not to cross thread the access plate retaining screw when securing the battery access plate.

The push button “**LISTEN**” control switch should only be depressed after the ground microphone has been firmly placed on a solid surface and one to two seconds Sensor Settle Time elapsed. When using the direct contact microphone, be certain that the tip is in firm contact with the pipe, valve box, etc., before depressing the “**LISTEN**” control switch.

B. Ground Microphone (Part No. 2916427)



(Figure 4)

1. General Specifications:

Construction: Acoustically suspended variable reluctance sensor

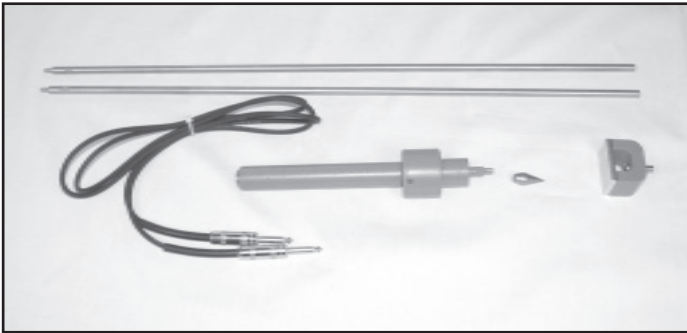
Impedance: 380 Ohm DC resistance

Frequency Response: 10 - 300 Hertz

Weight: Approximately 2 Lbs. 5 Oz.  
(1049 grams)

Figure 4 illustrates the Ground Microphone with the Ground Microphone Handle. The shock insulator minimizes sound coupling through the handle. The foam rubber sound seal restricts ambient noises, which may be present in the work area. The internal sensor is suspended and magnetically shielded to improve the signal to background noise ratio. The 1/4" plug mates with the 1/4" jack labeled "M" on the Amplifier Module via one of the two Microphone Cables.

C. Direct Contact Microphone (Part No. 2916428)



(Figure 5)

1. General Specifications:

Construction: Cold rolled steel case. Stainless steel sensor shaft, probe tip, and extension rods. Rods are 5/16" diameter. All threaded sections are #10-32 thread. Poured in place, the urethane core suspends the sensor shaft in the body for acoustical isolation. Each Direct Contact extension is 24" long.

Sensor: Piezo-Ceramic, resonant at approximately 3000 Hz.

Frequency

Response: Approximately 300-6000 Hertz.

The Direct Contact Microphone, microphone tip, optional magnet, and two extensions are depicted in Figure 5. All threaded joints are stainless steel on the Direct Contact Microphone; probe tip, and the extensions. The 1/4" plug mates with the 1/4" jack labeled "M" on the Amplifier Module via one of the two Microphone Cables.

D. Headphones (part No. 2911352)



(Figure 6)

1. General Specifications:

Weight:                    Approximately 0.94 Lbs  
                                  (425 Grams)

Impedance:                600 Ohms DC resistance

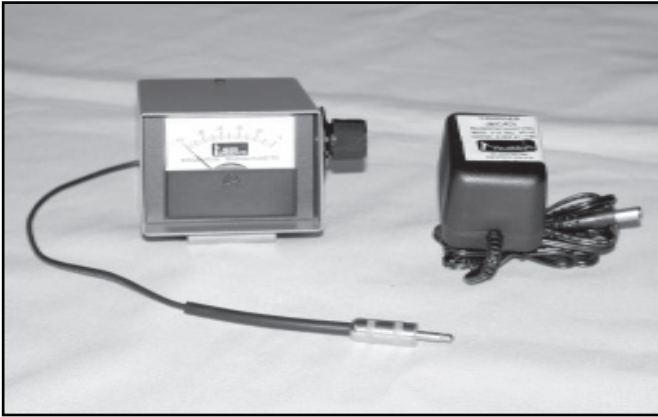
Frequency  
Response:                  40-18,000 hertz

Output:                    105 db

Type:                        Dynamic/dual/mono

The Headset used with the **AQUA-SCOPE** is depicted in Figure 6. The ear pads provide comfort to the user and minimize the reception at the ear of unwanted noises adjacent to the work area. The 1/4" monaural phone plug mates with the 1/4" phone jack labeled "H" on the Amplifier Module.

E. Meter Module (part No. 2923754)



(Figure 7)

1. General Specifications:

Weight: Approximately 1.2 Lbs. (545 Grams)

Size: Same as Amplifier Module

Battery: General Electric GC-9 Nickel Cadmium

Battery

Life: Approximately eight hours after a complete charge. Charge time is sixteen hours. Nominal overall life is 1000 complete discharge cycles.

Meter: 0-1 milliampere D.C.

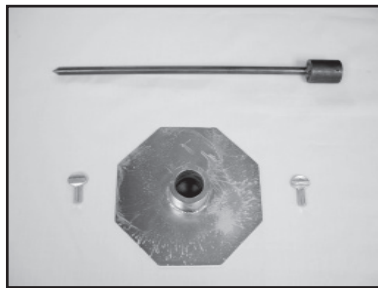
Amplifier

Gain: 200 volts/volt maximum. Meter response is matched to the Amplifier Module output.

Figure 7 illustrates the Meter Readout Module, an accessory item with **AQUA-SCOPE®**. The charger plug/jack system differs from the plugs and jacks used with other **AQUA-SCOPE®** components to minimize error. A rechargeable nine-volt battery, internal to the Meter Readout Module, powers the instrument.

**BATTERY TEST:** The internal battery may be tested by depressing the square button “Battery Test” switch shown in Figure 7 while observing the Meter (the instrument must be turned “ON”). The Meter must read a minimum of 0.7. If a lower reading is obtained, a complete recharge is required.

F. Resonant Plate (part No. 2921326).



(Figure8)

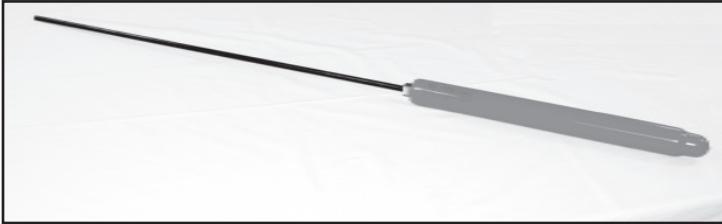
1. General Specifications:

**CONSTRUCTION:** 1/8” steel, octagonal plate.  
Approximately 6 1/2” diameter maximum.

**WEIGHT:** Approximately 2.5 Lbs. (1135 Grams).

The Resonant Plate shown upside down with the contact rod and thumbscrews not assembled in Figure 8 is used to enhance water leak detection in unpaved areas. The Ground Microphone rests on top of the Plate during use.

G. Plunger Bar



(Figure 9)

1. General Specifications:

Weight: 13 Lbs. (5.9 Kg)

Length: 62" (assembled)

Bar Length: 40"

Bar: Standard Steel Tempered

For unpaved areas the Plunger Bar is driven to the depth desired. The Plunger Bar is utilized as a sub-surface probe, which provides additional listening points when used with the Direct Contact Microphone.

For unpaved areas the Plunger Bar is driven to the depth desired. The Plunger Bar is utilized as a sub-surface probe, which provides additional listening points when used with the Direct Contact Microphone.



## CHAPTER TWO

### III. PRINCIPLES OF SOUND:

#### A. Engineering References

This section will cover the basic physics of sound. Section B will attempt to relate a few of these principles to the field of underground leak detection and pinpointing.

Wave motion, of which sound is but one example, is classically regarded as either transverse or longitudinal. In transverse wave propagation the wave travels perpendicular to the motion of the source (a plucked string is an example). Longitudinal waves progress along the axis or body of the media (listening for a train on its tracks is an example).

The audible limits of sound frequency for people are approximately from 20 to 20,000 hertz. The human ear responds to sound pressures from 0.0002 to 2000 dynes/cm (seven orders of magnitude). Sound intensity is generally expressed on a logarithmic scale (Decibels, or dB) with the reference intensity taken to be 10<sup>-16</sup> watt/cm, so that:

$$\left( \frac{I_{\text{Observed}}}{I_{\text{Reference}}} \right)$$

$$\text{INTENSITY LEVEL IN DECIBELS} = 10 \log$$

In addition the sound pressure (with the reference pressure taken as 0.0002 dyne/cm) is given by:

$$\left( \frac{P_{\text{Observed}}}{P_{\text{Reference}}} \right)$$

$$\text{SOUND PRESSURE LEVEL IN DECIBELS} = 20 \log$$

An upper limit exists for this sound pressure depending on the media involved. For air the upper limit is approximately 191 dB. At this level rarefaction of the wave causes cavitations and the wave breaks down since the media can no longer support it. The pain threshold for audible sound is at an intensity level of 120 Decibels.

The Transmission Velocity of Sound in an extended solid is given by:

$$\text{VELOCITY Longitudinal} = \sqrt{\frac{E_B + 1.333 E}{\rho}}$$

Where:  $E_B$  = The Bulk Modulus (Rigidity) of the Solid

$E_S$  = The Shear Modulus (Resistance to Deformation) of the Solid

$\rho$  = Density

In the case of a transverse wave in an extended solid, the Velocity is determined by the Shear Modulus alone and is expressed as:

$$\text{VELOCITY Transverse} = \sqrt{\frac{E_S}{\rho}}$$

If we now divide the Longitudinal Velocity by the Transverse Velocity in an extended solid, we note that:

$$\frac{v_L}{v_T} = \sqrt{\frac{E_B}{E_S} + \frac{4}{3}}$$

Or that the Longitudinal Velocity always exceeds the Transverse Velocity. This fact is used in Seismology to determine the point or origin of earthquakes.

Since a fluid cannot sustain a shear ( $E_S = 0$ ), no Transverse Wave can be transmitted in a fluid and the Longitudinal Velocity is given by:

$$v = \sqrt{\frac{E_B}{\rho}}$$

Where:  $E_B$  is the Adiabatic Bulk Modulus.

The Velocity of Sound is given by:

$$V = \sqrt{\gamma \frac{RT}{m}}$$

Where: V = Velocity

$\gamma$  = the ratio of the specific heat at constant pressure to the specific heat at constant volume.

R = the universal gas constant.

T = Absolute Temperature (degrees Kelvin).

m = Gram Molecular Weight of the gas.

Therefore, the Velocity of Sound in Air is:

$$V = \sqrt{\gamma \frac{RT}{29}} \text{ meters/sec.}$$

Velocity = 331

(At 68° F the velocity = 1125 ft./sec.).

The resonant frequency of rods, plates, pipes, strings, etc. is a function of the shape, density, elastic properties, and boundary conditions defining the object(s). In the case of a string, the fundamental resonant frequency is proportional to the Transverse Velocity and inversely proportional to length.

Sound dissipation along a fixed length of rod or pipe will be effected by transit time, constraining forces along the wall perimeter, and the media in the pipe. Discontinuities may drastically reduce sound transmission. Point source sound propagating in a spherical pattern dissipates (with no consideration of losses due to absorption reflection or interference) in sound pressure per unit area as the square of distance. This means a pressure decrease of 12 decibels each time the distance traveled doubles.

Sound waves, like other forms of energy, experience reflection and refraction at the boundary between two media. Interference can occur when two waves from the same source travel different path lengths and reunite.

Absorption of sound by materials is a science in itself. Terms often stated by acoustical wall manufacturers are seal and absorption loss. Seal refers to sweep strips used on doors to attenuate the transmission of higher frequencies. Absorption loss or door rating in decibels tends to increase as the number of laminates (metal, wood, fabric, etc.) increases. The higher frequencies are attenuated more dramatically than low frequencies. Sheet lead is often used to reduce plenum crossover.

Finally, the effect of paved surfaces on sound pick-up should be discussed. For lack of a better name, let us call it the Diaphragm Effect. Because of the large area and low modulus, the resonant frequency will be low. This surface, therefore, tends to amplify noises of low frequency occurring in the soil beneath the paved area and helps immeasurably in water leak location.

## B. Relating Sound Principles to Leakage Detection

The detection and location of underground leaks is implemented by a variety of instruments and numerous methods. For the purpose of this section, we will discuss the use of the **AQUA-SCOPE** and some of the general conclusions we might draw from the previous section in that regard.

The Direct Contact Microphone is generally placed against the surface of a pipe in a position nearly perpendicular to the pipe direction. The sensor responds to vibration along the axis of the Direct Contact Microphone. Therefore, the instrument is most sensitive to transverse sound waves on the pipe. Likewise, sound induced by leaks will be oriented more likely in a transverse mode. Now no sound can be transmitted through the fluid or gas in the pipe in a transverse mode based on the previous section. This means that the pipe wall must carry any transverse sound transmission alone.

The frequency and velocity of the sound induced on the pipe by a leak will be a function of pipe size, thickness, material and boundary conditions. Quite important is the rigidity of the pipe. Metal pipe has a high modulus. Therefore, we will hear the characteristically higher frequency “pipe” noise generated by a leak. Also, the velocity will be high or the transit time is short and minimum attenuation of the sound will result. Plastic pipe has a much lower modulus and, for similar conditions of pipe size and boundary conditions, the frequency will be lower with much higher transit time (attenuation).

Other sounds may also be generated by restrictions within the system, such as: a partially closed valve, a reduction coupler, a booster pump, etc. These devices will cause turbulence along the pipe wall and will emit a detectable sound similar to that of a leak. Do not be misled by this effect. If these sounds are of sufficient magnitude, you may be incapable of distinguishing the existence of a leak in the immediate vicinity.

Soil is basically a non-homogeneous material. Generally the soil will be layered except directly over man-implanted objects such as pipe. Fluidic type soils such as clay can create special problems. Any soil which has a rubber like consistency will greatly attenuate sound.

The actual contact area of the Ground Microphone with a surface is quite small. If a hard surface (even frozen earth will help) is unavailable, the use of a resonant plate may help. Any solid structure penetrating or covering the earth can be used to advantage.

Sound may be induced on a pipe by secondary noises such as leaking water filling a cavity. Once the cavity fills this source of noise vanishes.

## CHAPTER THREE

### IV. AQUA-SCOPE USER'S GUIDE:

#### A. Application

The pinpointing of unknown water leakage can be accomplished by the use of a combination of components, which make up the kit. By using different microphones and by amplification with a solid-state receiver, the sounds of water leaking from the line can be localized and pinpointed. The type or pitch of the sound varies from the deep roaring of a main up to a very high whining of leaking valve packing. It is necessary to differentiate these sounds from the other normal background noises.

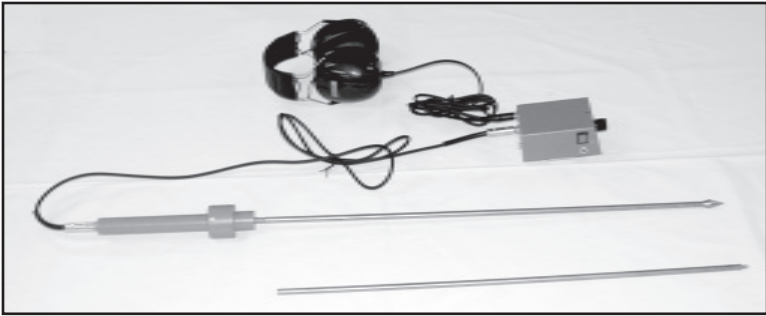
**Auxiliary Means - Plunger Bar:** Useful when searching for leaks on soil or sod covered pipes. Surfaces of this nature are poor sound transmitters and require the use of a bar as an auxiliary sounding.

**Resonant Plate:** The Resonant Plate is a specially machined plate, which improves the sounding qualities. The Plate is designed to accept the Ground Microphone.

#### B. Leakage Detection with the Direct Contact Microphone

**Preliminary Detection with the Direct Contact Microphone:**

The Direct Contact Microphone is used for preliminary detection in direct contact with an accessible part of the main, hydrant, curb valves, or directly on the service in the house, etc. The intensity of this direct contact is always in direct relationship to the distance of the leak from the point of measurement and indicates where the leak might be. By acoustic comparison of the noise heard in the Headset and by visual observation of the noise strength with the aid of the optional meter readout module at one or more points of measurement, the leak can be approximately located.

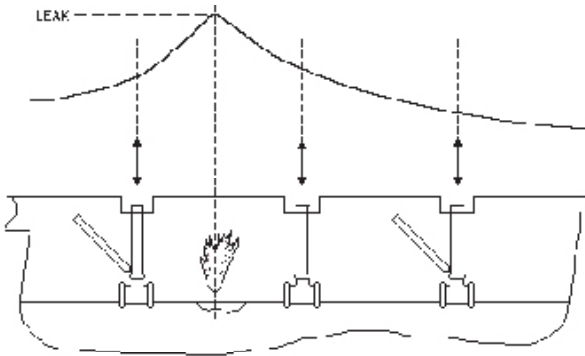


(Figure 10)

As you can see from Figure 10, in preliminary detection the Direct Contact Microphone is connected with the Amplifier Module and the Headset is plugged into the jack on the Amplifier Module. The Volume is then turned clockwise and the amplification is turned up enough so that the sound of a leak is recognizable. The position of 4 to 6 on the volume control is recommended for best sound intensity.

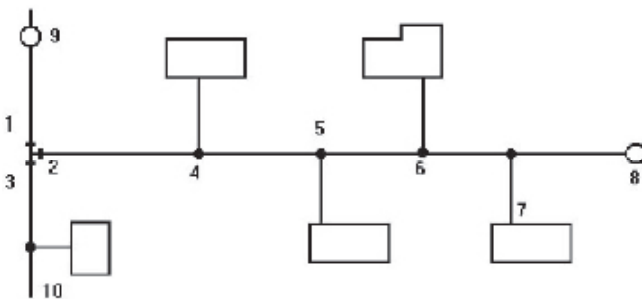
Procedure of Preliminary Detection: The point of the Direct Contact Microphone is placed on the part of the line, which is to be checked. The point should be abraded and firmly held against the line to insure good contact. When the Direct Contact Microphone is firmly placed on the line, the “**Listen**” control switch on the Amplifier Module is depressed. This will complete the electrical contact between the microphone and the amplifier. The switch should not be depressed before or while making contact, as the noise of making contact is unpleasant to the ear. Tests are made in this manner and sound levels for the tests compared (see Figure 11). Figure 12 is an example of the above technique in a field situation. The Direct Contact Microphone should not be immersed in water. If a test must be taken in deep water, use the extensions or contact the line or desired test point with a rod or key. The tip of the Direct Contact Microphone is then used on the rod or key.

## SOUND LEVEL INTENSITY AT DIFFERENT TEST POINTS



(Figure 11)

Example of a Preliminary Detection (Figure 12): After opening valve boxes on the main at 1, 2 and 3, the valve stems are checked with the Direct Contact Microphone. At all three valves a small noise is recognized. The noise at valve 2 is a little bit louder but it is not enough louder to determine a difference in the intensity of sound. To decide the further direction of examination, take comparative measurements at curb valve 4, at hydrant 9 and at curb valve 10. While the noise at point 4 is louder, no noise is heard at point 9 and 10. The search is continued in the direction of point 4. Further listening at points 5 and 6 shows a small increase of intensity of sound and a slight decrease at point 7.



(Figure 12)

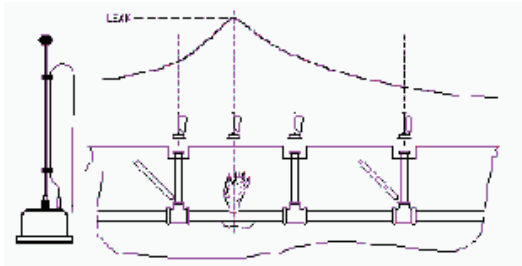


At point 7 there is no curb valve present nor is there any accessible contact point on the service to the house. Therefore, a direct contact inside the house is necessary. At hydrant 8 the noise is also very much smaller. This acoustical preliminary detection can be accomplished with far more ease by using the meter on the optional Meter Readout Module. At this time by listening to the loudest noise that has been detected, a medium reading of the scale is to be set. In this example, at measurement point 5, a reading of .60 units is set on the scale by turning the Meter Readout Control Knob clockwise while a test is being taken. This setting is recommended to be able to see an increase or a decrease of the reading on the instrument at the different test points. For all further comparative measurements, the setting of intensity of sound and meter are not to be changed, as any change during comparisons will affect the uniformity of the test. If a change in setting is necessary, all comparative tests must be repeated at the new setting. Meter reading at point 4 gives a decrease of reading down to .15 units, which would substantiate the acoustical result. On the other hand, the meter reading at point 6 shows an increase to nearly .70 units. This indicates further search towards point 7 is necessary. The test in house 7 is conducted with an unchanged setting of the instrument. It gives another decrease in instrument reading of .30 units. But we are to keep in mind that the length of the service (the test was taken in the house) might influence the result of the test. The final measurement at hydrant 8 is less than .10 units. Following this preliminary detection, the leakage should be near point 6. Pinpointing is now conducted with the Ground Microphone.

### C. Pinpointing With The Ground Microphone

The Ground Microphone is exchanged for the Direct Contact Microphone. The “**Listen**” Control switch at the upper left of the instrument is the interface between the Microphone and the Amplifier and should only be depressed when the Ground Microphone is placed in a test position. In working with the Ground Microphone, use a setting of 4 to 6 units of amplification. Using higher sensitivity by opening the sensitivity (volume) control will also give an amplification of background noises.

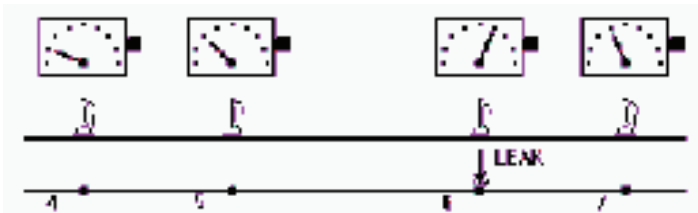
## SOUND LEVEL INTENSITY AT DIFFERENT TEST POINTS



(Figure 13)

For the pinpointing of the leak, the Ground Microphone will be placed as exactly as possible over the water main or service with test points a maximum of 6' apart. All noises received are to be compared with each other. The approach to the leak will be recognized by a higher intensity and increase of the noise. Above the point of leakage the intensity will reach a maximum. As you pass the leak the intensity will decrease. The meter reading will show the same result as the Audio test.

Example of a Pinpointing Situation:



(Figure 14)

In the example of the preliminary detection (Figure 14), a leak near the point of measurement number 6 was anticipated. For final pinpointing with the Ground Microphone, the section between points 4 and 7 will be checked at close intervals (3' to 6'), and near point 6 you will find a very strong noise. This is the source of the leakage. When doing such examinations with the Ground Microphone you should extend the test pattern as the leak may cause false noises. Some examples from practical use are detailed later in this Guide.

## Influence of the Leak Noise (Material of the Lines):

You should know the material of the line being tested as the sound transmission of leak sounds vary greatly from cast iron, to steel, to asbestos cement, and PVC. A simple example to clarify this: If a steel line, suspended from a cable is struck with a hammer, it will sound like a gong. A plastic or asbestos cement line would give a thumping noise on impact but it wouldn't resonate the sound at all.

**Pressure in the Lines:** The pressure in the line is also a very important factor. High pressure normally gives a loud noise, a high frequency, and good sound characteristics for localization. It generally can be said that a pressure of twenty pounds per square inch (PSI) is sufficient enough to locate leaks. Under twenty PSI it may be necessary to use auxiliary means.

**Special Circumstances Encountered:** The conditions of the cover over the main will especially influence the detection of the leak noise. A very hard ground has a better efficiency for sound transmission and is of higher resonance than muddy ground or sod. Sand and compact sand and stony grounds are very efficient sound transmitters.

On the other hand, the transmittance of sound under frozen ground may be so excellent that it is very difficult to locate the maximum (Loudest Point) since a large section of the frozen earth will be vibrating.

**Surface:** The surface in the environment can greatly influence the detection. It is necessary when pinpointing to consider the surface on which the Ground Microphone is placed. A change in the kind of surface (from sod to asphalt, for example) from one medium to the other may cause a very contradictory test value. This can sometimes cause so many differences of noise that a real comparison of noises for the leak detection may be difficult.

**Time of Work:** The choice of day or night testing is very dependent on the local situation. In rural or residential areas work during the day is possible. In areas with heavy traffic noise, loud machines, and/or factories, work during evening or night hours may be necessary.

## D. Exercises with the Direct Contact/Ground Microphone

Initially it is necessary to become acquainted with the background noise of the instrument under different positions of intensity.

Beyond positions 6 and 7, the Amplifier noise is easily heard. To have some idea about the efficiency of amplification, the Direct Contact Microphone should be tried with different positions of intensity while in contact with a mechanical type watch. Due to the high amplification, the sound of the watch, which is normally not heard, is as audible as the noise of a small leak.

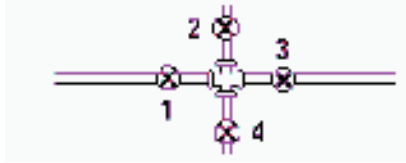
The third exercise is the amplification of a typical noise of water usage. This is especially true on metallic lines. For this purpose a Direct Contact Microphone will be (with the position of Volume set from 4 to 6) placed in contact with a curb valve and one of the faucets in the house and also some faucets of houses in the neighborhood opened. Open and close each of these outlets in the sequence of several seconds. Exercises on different types of pipe material will give some idea on transmission of sound.

Exercises with the Ground Microphone: Listening to background sounds using various sensitivities is necessary. For example, check to hear the sound of a walking pedestrian. Become acquainted with the change of background noise when you are placing the Ground Microphone over different surfaces, such as pavement, sod, or other types of surfaces. With the Ground Microphone directly at the curb wall over a service line valve, water flowing through the service might be heard. Opening and closing the outlet also is recommended as an exercise.

Type of Leak and Different Types of Leak Noises: The experienced listener will know from the type of noise which type of leak is present, the distance of the leakage location, and also the type and amount of leakage. Small holes, especially in steel lines under high pressure, will give very high frequency sounds. A total breakdown of the line with a large amount of water leaving the line will produce a typically deep roaring sound.

If you are inspecting an intersection with several valves, these results may be predicted:

1. Using the Direct Contact Microphone at point 3, a leaking valve packing will give a very high pitched sound. Using the same amplifier intensity at points 1, 2, and 4, will result in much lower sound readings on the meter.



(Figure 15)

2. A total break of the line at point 3 will give nearly similar values on the meter at all four test points. However, a slight increase at point 3 will indicate the direction for further search.

#### E. Graphical and Numerical Determination of the Point of Leakage

The reading of the exact measurement of sound intensity with the instrument allows the graphical or the numerical determination of the location of the leak. The procedure, therefore, is controlled measurement with the Direct Contact Microphone at two points on the same line at two valves, two hydrants, two curb valves, or at two direct contacts if the line is exposed. For these measurements it is recommended to use the optional Magnet Attachment, which will provide uniform contact and will give very constant values. It is necessary to observe the sound over a period of time to determine an average value if the reading is changing. For this method we assume that the product of sound intensity and distance is a constant. Therefore, for two points A and B and distance XA and XB from a leak:

$$I_A X_A = I_B X_B$$

Where:  $I_A$  and  $I_B$  are the values for intensity at points A and B respectively, and the total distance between test points is:

$$X_A + X_B = X$$

This gives two simultaneous equations:

$$IA XA - IB XB = 0$$

$$XA + XB = X$$

$$XA = \frac{\begin{vmatrix} 0 & -IB \\ X & 1 \end{vmatrix}}{\begin{vmatrix} IA & -IB \\ 1 & 1 \end{vmatrix}} = \frac{IBX}{IA + IB}$$

$$XB = \frac{\begin{vmatrix} A & 0 \\ 1 & X \end{vmatrix}}{\begin{vmatrix} IA & -IB \\ 1 & 1 \end{vmatrix}} = \frac{IAX}{IA + IB}$$

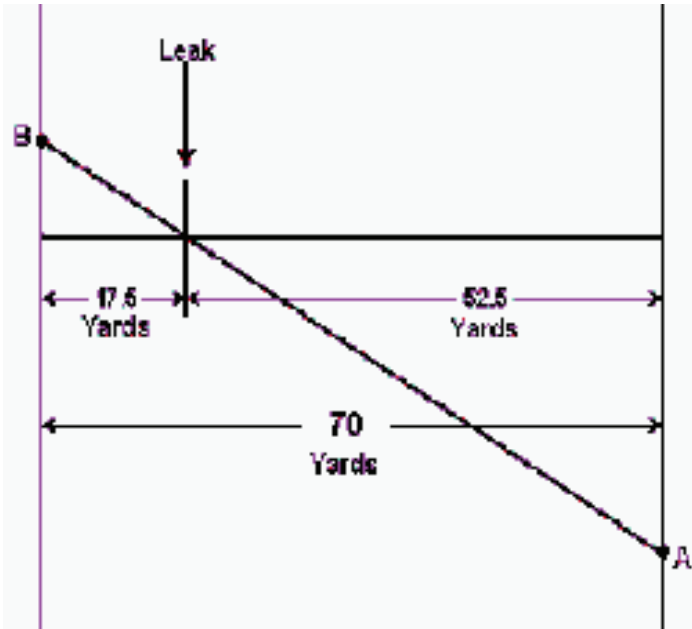
Example: Making contact measurements using the Magnet Attachment, we check two hydrants separated by a distance of 70 yards. At hydrant A we read .30 units and at hydrant B we read .90 units. We plot this graphically by first laying off the X-axis as the total distance between hydrants, or 70 yards. We now mark off the value of intensity for hydrant A along the positive Y-axis. LABEL THIS POINT B. At distance X from the origin, draw a perpendicular. Starting at X and moving in the negative Y direction, lay off the value of intensity for hydrant B. LABEL THIS POINT A. Draw a straight line from point B to point A. Where this line intersects the X axis is the point of leakage. Note the inversion of points A and B.

By the numerical technique the distance from test point A to the leak is:

$$XA = \left(\frac{.9}{.9 + .3}\right) \times 70 \text{ Yards} = 52.5 \text{ Yards}$$

Similarly:

$$XB = \left(\frac{.3}{.9 + .3}\right) \times 70 \text{ Yards} = 17.5 \text{ Yards}$$

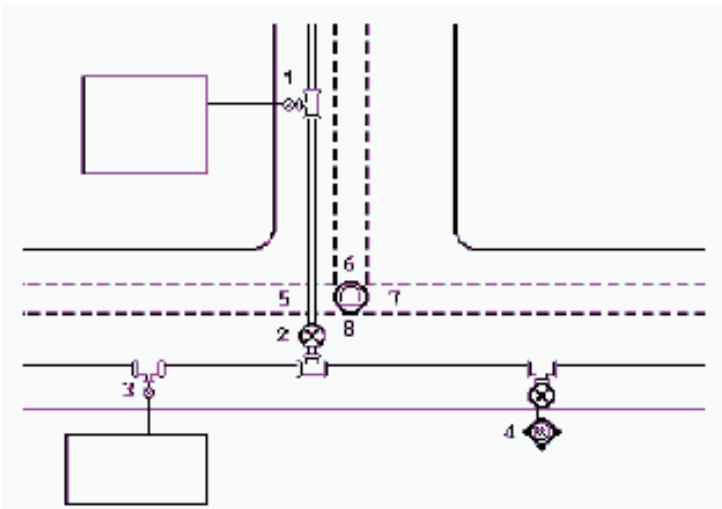


(Figure 16)

The graphical as well as the numerical solution are only preliminary determinations. The ideal case of two equal contact measurements is so remote, that a check with the Ground Microphone is always recommended.

## F. Practical Examples

Test probe measurement at valve 1 is .40 units; at valve 2, .90 units; at valve 3, .10 units, and at hydrant 4, zero units. This indicates the leak should be between points 1 and 2. Using the Ground Microphone, point 5 is the strongest test. A sewer is present at point 5. This noise could be the sound of water flowing in the sewer. If this is the case, tests at 6, 7, and 8, the other sides of the sewer, the same intensity of sound should be found. The comparatives show at point 5, .60 units and the other points (6, 7, and 8), a decrease. This confirms the leak is at point 5. The combination of the acoustical and numerical tests is conclusive in this instance.

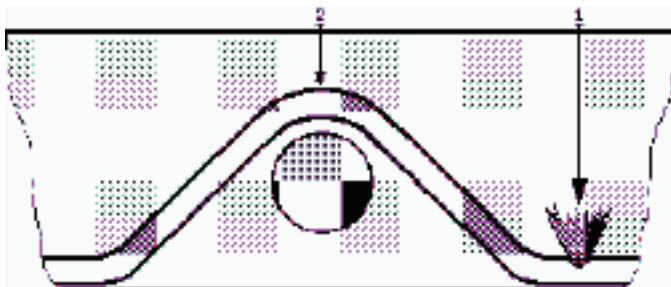


(Figure 17)

Houses without curb valves in a leakage area should be tested with the Direct Contact Microphone directly on the service line in the basement.

Checking with the Ground Microphone at point 2 gives a very strong test. At point 1 a weak test is noted. The leak is at point 1. This is caused by surface proximity and increased pipe turbulence sound at a bend in the pipe. It is necessary to know the location of bends, as they will cause an error in pinpointing if they are not taken into consideration. Difference in pipe location will influence the measurement. In case of doubt, drawings of local situations or a pipe locator should be used.





(Figure 18)

The noise of the leak should be checked with the Direct Contact Microphone at hydrant 4 and at valve 6. Pinpointing with the Ground Microphone will give a strong noise at point 5. However, at bend points 1, 2, and 3 a high level of sound may be found.

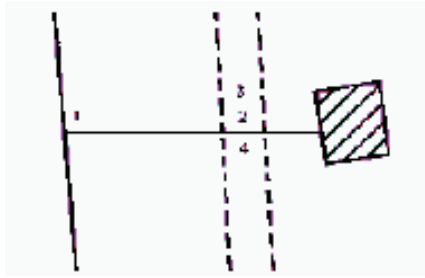
Please note the effect: Different depths in the cover over the main can give a varying intensity of the sound. It is always recommended to extend test areas and not dig at the first strong noise.



(Figure 19)

A restriction or a reducer in the line or a partially closed valve may cause a false leakage indication. Such cases seldom occur, but you never can exclude them. Such noises should be checked very carefully and then the restricted parts of the line should be eliminated if possible.

In checking the main, a leak noise is found at point 1. The next test of the house connection results in a strong noise at 2. But here a steeply sloped drain for wastewater is running. To eliminate this condition, the Ground Microphone is placed at 3 and 4. If the noise at 2, 3, and 4 yield the same instrument reading, it must be assumed that the drain is causing the sound and the leakage is at point 1.



(Figure 20)

### Leakage on Asbestos-Cement and Plastic Pipe

The very poor transmission of sound on this material will make other methods for detection necessary. The efficiency of using the Direct Contact Microphone for the preliminary localization will be diminished by the lack of sound transmission through the line. Also, if testing fittings with direct contact with the Direct Contact Microphone no sound of flowing water is heard, the presence of a leak cannot be excluded. It is recommended in all cases to check over the mains with the Ground Microphone at distances of 3 to 6 feet.

### Other Sonics

Some highly sophisticated sonic instrumentation has been developed using sound delay techniques, computer analysis, and analysis of sound waves on the oscilloscope. These methods are quite expensive but should be considered where conventional sonic methods are impractical.

## G. Alternate Methods of Leakage Detection

### Tracer Gases

For situations where sonic testing is completely impractical, the use of tracer gases should be considered. There are several tracer gas systems available and the following is a brief synopsis of advantages and disadvantages of four of these systems:

1. Nitrous Oxide with Infrared Detection: One of the advantages of nitrous oxide is that it is water soluble and the line does not have to be dewatered prior to the test. The infrared detector is very specific for nitrous oxide so that there is no need to worry about interfering gases. One of the real disadvantages of this system is that nitrous oxide is heavier than air so that holes must be probed to approximately the depth of the main. Two other disadvantages are that heavier than air gases are more difficult to pinpoint than lighter than air gases, and the infrared detection equipment is very expensive.
2. 10% Helium/90% Air: With this system, the line must be dewatered before the helium/air mixture is inserted. Helium has the advantage of being an extremely small molecule and very light. Detection is by Thermal Conductivity or Comparative Sonics.
3. Methane/Nitrogen: A mixture of 2 1/2% methane balance nitrogen, utilizing flame-ionization as the detector, is an extremely effective method. Methane, being lighter than air, requires no test hole placement. However, the line does have to be dewatered.
4. Flame-ionization detection of methane is in the low parts per million ranges, so that even small amounts of methane are readily detectable.
5. Methane/Argon: This mixture takes advantage of both a heavier and a lighter than air gas with the methane being detected by flame-ionization and the argon acting as a confirming gas being detected by comparative sonics. The helium and methane tracers require a pre-survey of the area before insertion of the tracer. They can all be interfered with by natural gas leaks or naturally occurring methane.

Tracer Gas Surveys are extremely expensive compared to Sonic Surveys and should only be considered when sonics are completely impractical.

## CHAPTER FOUR

### V. SERVICE INFORMATION:

#### A. Warranties and Warranty Repair

All instruments and products manufactured by the **Heath Consultants Incorporated** are warranted to be free from defects in material and workmanship for one (1) year from the date of shipment.

Furthermore, the warranty on authorized repairs in Houston FSC and regions is ninety (90) days materials and thirty (30) days labor. This repair warranty does not extend any other applicable warranties.

Our warranty covers only failures due to defects in materials or workmanship, which occur during normal use. It does not cover failure due to damage which occurs in shipment, unless due to improper packing, or failures which result from accident, misuse, abuse, neglect, mishandling, misapplication, alteration, modification or service by anyone other than a **Heath** warranty repair location.

Battery and damage from battery leakage and all expendable items such as filters and Plunger Bar rods are excluded from this warranty. Also, O-rings, gaskets and seals for the Petro-Tite product line are excluded from warranty coverage. In addition “wetted” parts in various Petro-Tite products are warranted for 30 days only.

Heath’s responsibility is expressly limited to repair or replacement of any defective part, provided the product is returned to an authorized warranty repair location, shipping charges pre-paid and adequately insured. Return shipping charges and insurance will be paid by Heath warranty expense.

We do not assume liability for indirect or consequential damage or loss of any nature in connection with the use of any **Heath** product.

There are no other warranties expressed, implied or written except as listed above.

The following suggestions will expedite the repair of your instrument:

Package carefully, using the original shipping carton, if available, return all components.

Specify your complete shipping and billing addresses.

Specify the instrument or product name, model number and serial numbers on all correspondence.

Include a brief description of the problem you are experiencing and specify person to be contacted for information.

**CUSTOMER ASSISTANCE, MANUFACTURING AND SERVICE  
LOCATIONS**

**CORPORATE HEADQUARTERS**

**Heath Consultants Incorporated**

9030 Monroe Road  
Houston, Texas 77061  
Phone: (713) 844-1300  
Fax: (713) 844-1309

**MANUFACTURING AND WARRANTY SERVICE CENTERS**

**Heath Consultants Factory Service Center**

9030 Monroe Road  
Houston, Texas 77061  
Phone: (713) 844-1350  
Fax: (713) 844-1398

**DIVISION OFFICES**

**Northeast Region**

1051 Garden Street  
Greensburg, PA 15601  
Phone: (724) 836-7830  
Fax: (724) 836-7835

**Central Region**

9030 Monroe Road  
Houston, Texas 77061  
Phone: (713) 844-1300  
Fax: (713) 844-1309

**Southeast Region**

1645 Murfreesboro Road, Suite E  
Nashville, TN 37217  
Phone: (615) 361-8306  
Fax: (615) 361-8651

**Western Region**

4100 S. Fremont Avenue, Suite 150  
Tucson, AZ 85714  
Phone: (520) 790-4971  
Fax: (520) 790-5016

*Heath Consultants Incorporated operates under a continual product improvement program and reserves the right to make improvements and/or changes without prior notification.*

Heath Consultants Incorporated

Houston, TX

713-844-1300

Fax: 713-844-1309

**1-800-HEATH-US**

**[www.heathus.com](http://www.heathus.com)**



*Heath...Safety, Leadership, Innovation, Performance  
Then, Now and Tomorrow*